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The management of skin infarction after meningococcal septicaemia in children

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SUMMARY. **The clinical course and management of 21 children (12 females, 9 males; mean age 2.4 years) with skin necrosis secondary to meningococcal septicaemia is described.**

Skin necrosis was most commonly sited in the lower limbs (20 patients). Sixteen patients had multiple areas of involvement and amputation of the digits was required in 5 patients. One required an above knee amputation. Small areas of skin necrosis were managed conservatively (4 patients) but larger areas required debridement and grafting. Skin grafting was delayed in 15 patients and graft loss occurred in 8. Multiple grafting procedures were required in 6 patients. Scar revision was required in 6 patients. Nutritional support is also an important component of management.

Although meningococcal infections are common in children, only 1 in 100,000 in the United States of America develops a significant illness (Gold and Joye, 1987; Behrman and Vaughan, 1987). When this occurs two clinical patterns can emerge. In the majority of cases, meningitis occurs without septicaemic shock. However, 10–20% of patients develop a fulminant septicaemia characterised by endotoxic shock, disseminated intravascular coagulopathy and haemorrhagic skin lesions which progress to skin infarction (Toews and Bass, 1974; Adendorff *et al.*, 1980). It is this latter group which is associated with a significant mortality that has not decreased over the past 30 years despite early treatment (Gold and Joye, 1987).

Meningococcal infections are endemic to the Western Cape of South Africa, occurring at an incidence of 20/100,000 population which is 4–5 times higher than the rest of South Africa. The reason for this is not clear.

This study reports the clinical manifestations and management of this disease in a major referral hospital over a 15-year period.

Materials and methods

The records of all patients with skin necrosis secondary to meningococcal septicaemia presenting to Red Cross Children's Hospital between 1977 and 1991 were reviewed. During this period 21 children were seen. There were 12 females and 9 males with an average age of 2.4 years (range 5 months to 6 years). Patients were only referred to the plastic surgery department after management of the acute septicaemic/endotoxic shock in the paediatric intensive care unit. While in this unit the skin lesions were treated with daily povidone iodine dressings. Once the septicaemia had resolved and the children were clinically stable, they were transferred to the plastic surgery department for management of the skin necrosis. The mean time to transfer was 19 days (range 9–32 days).

Treatment was conservative for small areas of skin necrosis.

Larger areas of necrosis were debrided and skin grafted, either primarily if the bed was considered adequate, or secondarily once bacteriological control of the wound was obtained and/or adequate granulation tissue had developed. Pus swabs were sent for culture and sensitivity prior to any grafting procedure.

Results

Site

The lower limbs were the most common site of skin necrosis and were involved in 20 patients. The trunk was involved in 8 patients and the arms in 9 patients. The face was involved in 4 patients and the scalp and ear in one patient respectively. Sixteen patients had multiple areas of skin involvement.

Surface area

The average body surface area (BSA) of skin necrosis was 12.9% (range 4%–35%).

Amputations

Amputations were required in 6 patients, and were performed proximal to the area of skin necrosis. The toes were amputated at the metatarso-phalangeal joint in 4 patients and the fingers at the level of the middle phalanx in one other. The digital amputations were allowed to heal by secondary intention. One patient

required an above knee amputation as a life saving procedure for peripheral gangrene with large areas of exposed bone. One patient developed gangrene of the tip of the ear, which was debrided and closed primarily.

Microbiology

Pus swabs taken at the time of transfer to the plastic surgery department demonstrated significant bacterial contamination of the wounds (> 100,000 organisms) in 19 patients. Usually multiple bacteria were cultured from the wounds. *Staphylococcus aureus* was the most commonly cultured organism and occurred in 18 patients. *Beta-haemolytic streptococcus* occurred in 4 patients, *Proteus mirabilis* in 7, *Escherichia coli* in 3, *Klebsiella pneumoniae* in 8 and *Pseudomonas aeruginosa* in 7.

Nutritional status

Only one child was malnourished on admission according to the Wellcome classification using National Centre for Health and Statistics Growth Charts (1976). On transfer to the plastic surgery department 17 patients had reduced levels of total protein and albumin. The mean total protein concentration was 55 g/l (range 35–65). The mean albumin concentration was 24 g/l (range 12–35).

Management

4 patients with small areas of necrosis (less than 5% BSA) were treated conservatively with daily povidone iodine dressings. The wounds healed spontaneously, but unsightly contracted scars ensued and one patient required revision surgery for facial scarring.

Larger areas of necrosis were debrided and grafted immediately (2 patients) or underwent delayed grafting (15 patients). Of the 2 patients who had immediate grafting, take was satisfactory in one but regrafting was required in the other patient. In the 15 patients undergoing debridement and delayed skin grafting, significant graft loss occurred in 8 patients and they required regrafting. Multiple grafting procedures were required in 6 patients. In 4 of these patients, perioperative pus swabs revealed significant contamination of wounds (> 100,000 organisms).

Follow-up

While in the ward the children received regular physiotherapy to ensure joint mobility. Once the wounds were completely healed, pressure garments were applied. The mean follow-up period was 14 months (range 6 months–5 years).

Complications

Secondary procedures of scar revision were performed in 6 patients. Another patient with full thickness loss of the skin over the knee joint developed septic arthritis and now has a 25° flexion contracture of her knee.

Discussion

Meningococcal septicaemia with associated skin infarction has a reported mortality rate of 15–20% (Behrman and Vaughan, 1987). The disease affects mainly infants and young children, although occasionally also involves young adults. Eighty per cent of cases have been reported to occur under the age of 10 years (Behrman and Vaughan, 1987). In our study the average age was 2.4 years. A higher incidence of meningococcal infection has been reported in males (Washburne *et al.*, 1965; Gaze and Murray, 1976). This contrasts with our experience, where a slight female preponderance occurred.

The purpuric lesions have a predilection for areas of the integument from which blood is shunted during the shock state (Seyfer *et al.*, 1989) and thus the limbs are the most common site of skin necrosis (Feldman, 1972; Toews and Bass, 1974). This concurs with our experience, although all areas of the body developed skin necrosis. The pattern of skin loss does not follow a dermatomal distribution (Schaller and Schaller, 1986). An average surface area of skin necrosis of 12.9% represents a considerable insult to the young child who is nutritionally depleted and has a diffuse vasculitis.

Amputations were required in 23% of our patients indicating the fulminant nature of this disease. However, most amputations can be performed distally at the level of the digits (Carson, 1985; Seyfer *et al.*, 1989) (Fig. 1) and more proximal major amputations are uncommon. In our series only one patient required an above knee amputation. Jacobsen and Crawford (1984) reported 5 children who required amputation following meningococcal septicaemia. However major amputations were only required in 2 patients viz.

Fig. 1

Figure 1—Gangrene of digits requiring amputation.

Fig. 2

Figure 2—Extensive skin necrosis involving both legs. Thick eschar present.

bilateral below knee in one and a Symes amputation in the other. Landham *et al.* (1991) reported 5 major amputations during a 10-year period, but these were performed in a group of young adults, following meningococcal septicaemia with associated skin necrosis.

The exact pathogenesis of the skin lesions remains obscure. Whittle *et al.* (1975) suggested that the cutaneous response is related to the host immune response rather than direct invasion of the tissues by the organism. It has been postulated that circulating endotoxin causes antigenic elaboration at the skin sites which have been primed during the bacteraemic phase. This process is similar to the Schwartzman reaction described in laboratory animals (Davis and Arnold, 1974; Adendorff *et al.*, 1980). Pathologically, the end result is a vasculitis with associated thrombosis and haemorrhage manifesting initially as petechial spots, which progresses to large purpuric areas and ecchymosis and finally to skin infarction with necrosis (Toews and Bass, 1974; Adendorff *et al.*, 1980). Typically the process involves the full thickness of the skin but occasionally underlying fat or muscle may also be involved (Schaller and Schaller, 1986; Seyfer *et al.*, 1989).

Management by the plastic surgeon has two facets, namely ensuring nutritional support and achieving skin cover. Nutritional support is important (Seyfer *et al.*, 1989) to enhance immunity and limit the catabolic process. The low levels of total protein and albumin reflect the severe catabolic state as a result of the severe infection and an ongoing exudative loss through the wound. Aggressive nutritional support is especially important in young children with extensive skin necrosis (Seyfer *et al.*, 1989).

Management of the skin necrosis presents a difficult problem. Early debridement and skin grafting is precluded by the state of the patient during the acute infective phase of the disease (Fielding and Jenkins, 1987). By the time the septicaemia has resolved the skin lesion has progressed to a wound with a thick necrotic eschar with superimposed wound infection. Part of the eschar may have separated with regular topical therapy (Fig. 2).

Small areas of skin necrosis can be managed conservatively (Seyfer *et al.*, 1989) and allowed to heal spontaneously, although unsightly contracted scar formation commonly occurs. Larger areas of skin loss require debridement and skin grafting (Schaller and Schaller, 1986; Fielding and Jenkins, 1987; Norman and House, 1990). Primary skin grafting is seldom successful (Adendorff *et al.*, 1980), for a number of reasons. Firstly as in burn wounds, granulation tissue at the interface between viable and non-viable tissue takes a few weeks to develop (Boswick, 1987). Secondly, the wounds are heavily contaminated (> 100,000 organisms) and are unlikely to accept grafts (Krizek and Robson, 1975). Biopsies of the unhealed wounds were not performed in this series. However, previous studies from this institution (Adendorff *et al.*, 1980) failed to demonstrate any difference between granulation tissue from these wounds compared to other wounds such as burns.

Skin grafting should only be undertaken once an adequate wound bed is present and control of the bacterial flora has been achieved (Adendorff *et al.*, 1980) and so is often performed as a delayed procedure. Attempts to resurface the wound before these objectives are achieved may waste valuable skin (Seyfer *et al.*, 1989). Schaller and Schaller (1986) used porcine xenografts until a clean, viable bed was obtained. Although skin flaps are another method of achieving wound cover, the underlying vasculitis precludes their use primarily (Adendorff *et al.*, 1980). Flaps may be employed in subsequent scar revision and reconstruction (Gaze and Murray, 1976).

Fulminant meningococcal septicaemia with skin necrosis presents a challenge to both paediatrician and plastic surgeon. Nutritional support is an important facet of management. Debridement should be performed as soon as the child is medically stable and skin grafting achieved as soon as the local wound environment permits. Long term follow-up is also required as secondary procedures may be necessary.

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