Classification of soft-tissue degloving in limb trauma

Z.M. Arnez a,d, U. Khan b,*, M.P.H. Tyler c

a Ospedali Di Cattanara, Strada di Fiume, 447-34149, Trieste, Italy
b Department of Plastic Surgery, Frenchay Hospital, Frenchay Park Road, Bristol BS8 1SY, UK
c Department of Plastic Surgery, Stoke Mandeville Hospital, Aylesbury, Buckinghamshire, UK
d Department of Plastic Surgery and Burns, Medical Centre, Zaloska Cesta, Ljubljana, Slovenia

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Summary Compressive, tortional and abrasive deforming forces are translated to the limbs during high energy trauma. The long bones may be fractured in many patterns with a varying extent of fragmentation and comminution but the soft-tissues appear to absorb the forces in a predictable way. We retrospectively reviewed a series of 79 complex limb injuries treated in a dedicated centre where the clinical notes and photo-documentation were meticulously kept and where the outcomes were known. The soft-tissue injuries were then described and revealed four patterns of injury: abrasion/avulsion, non-circumferential degloving, circumferential single plane and circumferential multi-plane degloving. These patterns occurred either in isolation or occasionally in combination. Resuturing of degloved skin was only successful in non-circumferential (pattern 2) cases. Radical excision of devitalised tissue followed by soft-tissue reconstruction in a single procedure was successful in all patterns apart from pattern 4 (circumferential multi-plane degloving). In pattern 4 we recommend serial wound excision prior to reconstruction.

Severe, complex limb trauma remains a challenge.1,2 The principles of management when there is an open fracture are becoming clear.2,3 Comprehensive excision of de-vitalised hard and soft-tissue followed by appropriate skeletal fixation and vascularised soft-tissue cover is the cornerstone of modern care.2,3 Degloving has been defined as avulsion of the skin off the underlying muscle and bone.4 However, when the soft-tissue envelope has been degloved the assessment of these tissues may be unclear. This makes the decisions of what to excise and what to conserve a difficult one. Direct visual inspection of the degloved skin is a weak predictor of the extent of injury.5 Use of intra-venous flouroscein has been proposed as a better method but may over-estimate the line of demarcation between viable and non-viable skin.6 The use of thrombosed sub-cutaneous veins have been proposed by Waikakul to mark the zone of demarcation.7 In another series it was proposed that 'test shaves' of the degloved skin may show this demarcation with brisk pink bleeding from viable tissue.8 Thus there are surrogate indicators of skin/fat vitality. There have also been publications describing novel ways to use the devitalised, degloved skin.9,10 Some have
advocated the use of a dermal equivalent in purely degloved skin without an open fracture.\textsuperscript{11} Degloving injuries have also not escaped the attention of surgeons advocating negative pressure dressing.\textsuperscript{12} What has hitherto not been made clear is whether categorisation of degloved integument can provide a means of prognosis when assessing the injury as a whole. This series of 79 cases which were treated in a specialist centre with direct involvement of the senior author (ZMA) were used to try and investigate this dimension in complex limb trauma.

Materials and methods

To describe the patterns of soft-tissue injury we retrospectively reviewed a total of 68 patients with a total of 79 injured limbs. The mean age was 29.5 (range 3–84) with 53 males and 15 females. Fifty one (65\%) were of the lower limb. Injuries with the following criteria were included:

1) all patients with a skin lesion greater than 5 cm with circumscribed degloving (ie a soft-tissue injury greater than IO/IC 3 on the AO/ASIF classification)\textsuperscript{13}

2) adequate photo-documentation of the initial injury to allow accurate classification prior to reconstruction.

3) injuries proximal to the metacarpals and metatarsals

The causes of the injury were: road traffic accidents in 45\%; pedestrian hit by vehicle 24\% and machinery/farm accidents 31\%. Two limbs went onto amputation. There were 40 long bone fractures (24 tibial; 6 femoral and 10 in the upper limb). The notes, X-rays and a total of 2043 slides (an average of 26 slides per injury) were reviewed.

Outcome measures

The management of all cases was radical wound excision and immediate wound cover as described elsewhere.\textsuperscript{14} Flap coverage was in 66\% cases the rest underwent skin grafting. A healed wound was defined as one which was free of any dressings. Whether the wound healed by primary healing defined as a healed wound within two weeks of reconstruction or by secondary healing Defined as a healed wound after two weeks of reconstruction was used as an outcome measure of our surgical strategy. The rate of primary healing was statistically compared for the four patterns using a chi-squared analysis.

Results

During the study it became clear that the soft tissue injury fell into distinct patterns as follows:

Pattern 1- Limited degloving with abrasion/avulsion

There is loss of tissue as a result of the abrasive force. There is little undermining of the remaining skin edges. Since the majority of these cases occurred over bony prominences (such as the malleoli) there is exposed bone/joints (Figure 1).

Pattern 2- Non circumferential degloving

In this pattern the majority of skin is still present either as a flap or as an area of extensive undermining. The plane of avulsions is, in the main, confined to a single layer (usually between the deep fascia and the subcutaneous fat and skin (Figure 2)).

Pattern 3- Circumferential single plane degloving

Either open or closed circumferential degloving of the integument confined to a single plane (usually between the deep fascia and the subcutaneous fat and skin — Figure 3).