



Lower limb injuries caused by improvised explosive devices: Proposed 'Bastion classification' and prospective validation

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ABSTRACT

Background: Complex lower limb injury caused by improvised explosive devices (IEDs) has become the signature wounding pattern of the conflict in Afghanistan. Current classifications neither describe this injury pattern well, nor correlate with management. There is need for a new classification, to aid communication between clinicians, and help evaluate interventions and outcomes. We propose such a classification, and present the results of an initial prospective evaluation.

Patients and methods: The classification was developed by a panel of military surgeons whilst deployed to Camp Bastion, Afghanistan. Injuries were divided into five classes, by anatomic level. Segmental injuries were recognised as a distinct entity. Associated injuries to the intraperitoneal abdomen, genitalia and perineum, pelvic ring, and upper limbs, which impact on clinical management and resources, were also accounted for.

Results: Between 1 November 2010 and 20 February 2011, 179 IED-related lower limb injuries in 103 consecutive casualties were classified, and their subsequent vascular and musculoskeletal treatment recorded. 69% of the injuries were traumatic amputations, and the remainder segmental injuries. 49% of casualties suffered bilateral lower limb amputation. The most common injury was class 3 (involving proximal lower leg or thigh, permitting effective above-knee tourniquet application, 49%), but more proximal patterns (class 4 or 5, preventing effective tourniquet application) accounted for 18% of injuries. Eleven casualties had associated intraperitoneal abdominal injuries, 41 suffered genital or perineal injuries, 9 had pelvic ring fractures, and 66 had upper limb injuries. The classification was easy to apply and correlated with management.

Conclusions: The 'Bastion classification' is a pragmatic yet clinically relevant injury categorisation, which describes current injury patterns well, and should facilitate communication between clinicians, and the evaluation of interventions and outcomes. The validation cohort confirms that the injury burden from IEDs in the Helmand Province of Afghanistan remains high, with most casualties sustaining amputation through or above the knee. The rates of associated injury to the abdomen, perineum, pelvis and upper limbs are high. These findings have important implications for the training of military surgeons, staffing and resourcing of medical treatment facilities, to ensure an adequate skill mix to manage these complex and challenging injuries.

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Introduction

Complex lower limb wounds and traumatic amputations caused by improvised explosive devices (IEDs) have become the signature injury of the conflict in Afghanistan.^{1–3} Insurgents favour the use of these devices because of their wounding power, and because deployment incurs relatively little risk to themselves. The IEDs currently encountered in Afghanistan are high in explosive

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Table 1

International Committee of the Red Cross (ICRC) classification of injuries from antipersonnel mines.

Injury pattern	Description
Pattern 1	Traumatic amputation of part of lower limb, less severe injuries elsewhere
Pattern 2	Multiple fragment wounds
Pattern 3	Injury to hands and face

content, often resulting in bilateral, proximal traumatic lower extremity amputations and associated pelvic injuries. This injury pattern, at least to this extent, has not previously been encountered. Traumatic amputation was uncommon during the second World War and the Korean war, but increased in frequency during the Vietnam war.⁴ Since then, the proportion of casualties who suffer traumatic amputation has remained relatively constant, but the extent and complexity of the injuries has increased.^{4,5}

Traumatic amputation requires expeditious, multidisciplinary management. The immediate priority is to attain vascular control. When the injury level is sufficiently distal, pneumatic tourniquets are used, followed by ligation of the injured vessels. More proximal injuries, however, represent an extreme form of junctional zone trauma, and may require indirect operative vascular control, by exposing and temporarily occluding the femoral or iliac arteries.⁶ Associated injuries such as pelvic fractures, genital and intra-abdominal injuries add further complexity and have a profound impact on management, including staffing. An accurate description is essential for communication between clinicians, and planning treatment. It is also essential for evaluating interventions and outcomes.⁷ Several recent reports have struggled to distinguish between minor and major amputations, limiting their conclusions.^{4,5} At present, there is no classification or grading system which fulfils this need. The 1991 International Committee of the Red Cross (ICRC) classification of mine injuries describes three broad patterns of wounding by antipersonnel mines (Table 1), but does not enable distinction between wounds of differing severity.⁸ Systems such as the mangled extremity severity score (MESS), Gustilo and Anderson and Müller–AO classifications do not provide information on injury level,^{9–11} and the utility of the MESS in the military setting in general has been found wanting.¹² The Gustilo and Anderson classification is insufficiently granular, as the majority of blast injuries currently encountered in Afghanistan fall into the grade IIIb (open fractures with inadequate soft tissue cover) or IIIc categories (associated with vascular injury requiring repair). The Müller–AO classification, while comprehensively descriptive of bone injury, does not take into account soft tissue injury.¹¹ Lastly, none of the three classification systems correlate with treatment need, such as requirement for operative proximal vascular control, or amputation level.

There is need for a classification of lower extremity injuries caused by improvised explosive devices. We propose such a classification, and the results of an initial prospective evaluation.

Methods

Derivation

The classification was developed by a panel of experienced UK and US military surgeons, during a series of consensus meetings, while deployed on OPERATION HERRICK 13, at the Joint Forces Medical Group Role 3 medical treatment facility at Camp Bastion, Helmand province, Afghanistan. The contributing surgeons, who have completed 5 deployments to Afghanistan between them, and their professional backgrounds are listed in Table 2. The consensus process commenced with an agreement that any classification must be clinically relevant, easily applied and reproducible.

Table 2

Consultant grade members of consensus group.

Contributor	Appointment
SAA	Consultant orthopaedic trauma surgeon, Royal Army Medical Corps
JOJ	Consultant general trauma surgeon & intensivist, Royal Army Medical Corps
AH	Orthopaedic trauma and spinal surgeon, US Navy

**Fig. 1.** Class 1S open mid/hind-foot injury, with viable forefoot.

Clinical relevance was defined as predictive of the initial musculoskeletal treatment, and the method of vascular control required. After a series of discussions, a consensus was reached that the level of injury should be defined anatomically, as the most proximal extent of non-viable tissue or skeletal injury. It was furthermore agreed to categorise injury level as confined to the foot (class 1); involving the lower leg (permitting an effective tourniquet to be applied below the knee, class 2); involving the proximal lower leg or thigh (permitting effective tourniquet application above the knee, class 3); involving the proximal thigh (not permitting effective tourniquet application, class 4); or involving the buttock (class 5). These levels, summarised in Table 3, were selected as having face validity, being readily identifiable, and representative of current practice in terms of the method of vascular control employed. Examples of the five classes of injury are shown in Figs. 1–8.

Not all injuries involve complete amputation of a limb. IEDs may inflict other, complex injuries, involving bones and soft tissues, frequently in association with distal or contralateral traumatic amputations. The consensus group therefore decided to include these injuries in the classification. A segmental injury was defined as the presence of potentially viable tissue distal to the most proximal injury, and denoted by the suffix “S”, while retaining the above classification of injury level, because it pertains

Table 3

Bastion classification of lower limb injury caused by IED. The most proximal extent.

Class of limb injury	Description
1	Injury confined to foot
2	Injury involving lower leg permitting effective below-knee tourniquet application
3	Injury involving proximal lower leg or thigh, permitting effective above-knee tourniquet application
4	Proximal thigh injury, preventing effective tourniquet application
5	Any injury with buttock involvement

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