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Amputation: Not a failure for severe lower extremity combat injury

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ABSTRACT

Introduction: The use of improvised explosive devices is a frequent method of insurgents to inflict harm on deployed military personnel. Consequently, lower extremity injuries make up the majority of combat related trauma. The wounding pattern of an explosion is not often encountered in a civilian population and can lead to substantial disability. It is therefore important to study the impact of these lower extremity injuries and their treatment (limb salvage versus amputation) on functional outcome and quality of life.

Patients and methods: All Dutch repatriated service members receiving treatment for wounds on the lower extremity sustained in the Afghan theater between august 2005 and August 2014, were invited to participate in this observational cohort study. We conducted a survey regarding their physical and mental health using the Short Form health survey 36, EuroQoL 6 dimensions and Lower Extremity Functional Scale questionnaires. Results were collated in a specifically designed electronic database combined with epidemiology and hospital statistics gathered from the archive of the Central Military Hospital. Statistical analyses were performed to identify differences between combat and non-combat related injuries and between limb salvage treatment and amputation.

Results: In comparison with non-battle injury patients, battle casualties were significantly younger of age, sustained more severe injuries, needed more frequent operations and clinical rehabilitation. Their long-term outcome scores in areas concerning well-being, social and cognitive functioning, were significantly lower. Regarding treatment, amputees experienced higher physical well-being and less pain compared to those treated with limb salvage surgery.

Conclusion: Sustaining a combat injury to the lower extremity can lead to partial or permanent dysfunction. However, wounded service members, amputees included, are able to achieve high levels of activity and participation in society, proving a remarkable resilience. These long-term results demonstrate that amputation is not a failure for casualty and surgeon, and strengthen a life before limb (damage control surgery) mindset in the initial phase. For future research, we recommend the use of adequate coding and injury scoring systems to predict outcome and give insight in the attributes that are supportive for the resilience that is needed to cope with a serious battle injury.

Introduction

In the new era of modern (fourth) generation warfare, conventional weapons are often replaced by more improvised methods used by insurgents to harm military personnel, local security forces and civilians [1]. In the recent conflicts in Iraq and Afghanistan, the primary mechanism of injury from battle casualties has been explosion, mainly through use of Improvised

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Explosive Devices (IEDs) [2–11]. The majority of injuries are inflicted to the lower extremity since most of IEDs are being dug in, and bodily armor generally does not protect the extremities [6,12,13].

The use of explosive devices as mechanism to inflict injury also affected the Dutch Armed Forces in recent conflicts. Between 2006 and 2010, during their involvement in the ISAF operation in Afghanistan, the Dutch Armed Forces suffered 199 battle casualties (physical injuries), and 30% of all injuries were inflicted to the lower extremities. IEDs where in 74% the main mechanism of injury [14].

The wounding pattern of an explosion in combat situations is hardly comparable with regular wounding patterns in a general civilized environment, with the exception of those seen with terrorist attacks using explosives in urban areas as recently in Paris and Brussels. Due to the nature of an explosion, the injury mechanism of an IED consists of a quinary pattern [15,16]. Depending on being in an enclosed space (vehicle) or open (foot patrol), the effects of these phases on the body is different [17]. Effects of these phases on extremities are outlined by Ramasamy et al. [18] Many of these lower extremity injuries have shown good survivability, partially due to improvements in the medical support chain (pre-hospital use of tourniquets, rapid evacuation and adequate transfusion protocols) [19–24]. However, these injuries can lead to substantial disability that will require numerous resources [25]. The impairment that follows generally undermines the well-being of an injured service member [26]. Therefore, the objective of our study was to investigate (1) the functional outcome and quality of life of Dutch deployed service members with lower extremity injuries that required repatriation out of theater, (2) differences in these outcomes between battle casualties (BCs) and service members that sustained non battle injuries (NBIs) and finally (3) whether outcomes differed between treatment with limb salvage surgery and amputation and to which extent pain is of influence on outcome scores. We aim to contribute to the discussion in the management of lower extremity injuries sustained in combat.

Methods

All Dutch service members who were repatriated due to injuries sustained in Afghanistan between 2005 and 2014 during Operation Enduring Freedom (OEF: 2001–2011), the International Security Assistance Force mission (ISAF: 2006–2010) or the European Police training mission (EUPOL: 2011–2014), were identified from the archives of the Central Military Hospital in Utrecht, the Netherlands. The information was collated in a database that was specially designed for this study. All battle and non-battle casualties with any injury to the lower extremity were included. These deployments normally have a time-period that varies between 5 and 12 months. Servicemembers who deploy for a period of 12 months have a (optional) rest and recuperation (1–3 weeks) midterm. Demographic information comprised of sex and age at time of incident. Furthermore, information concerning injuries and hospitalization was collected also. Injuries were coded according to the Abbreviated Injury Scale © 2005, update 2008 [27]. Injury severity was measured by calculating the ISS and New Injury Severity Score (NISS) [28,29]. Lower extremity injuries with an AIS $\geq$ 3 were regarded severely enough that possibly a decision needed to be made whether to treat the injury with limb salvage surgery or amputation. For analyses, amputation was defined as any traumatic (at scene), primary (decision within 24 h) or secondary/delayed amputation (for example secondary procedure within the first admission) at any level between metatarsals and hip.

The included service members were contacted and asked to participate in this study by conducting an online survey about their functional ability and quality of life. The survey consisted of the questionnaires Short Form health survey 36 (SF-36), EuroQol-6D (EQ-6D) and Lower Extremity Functional Scale (LEFS) [30–34]. Additional demographic information was inquired consisting of rank, unit and function at time of incident. Participating service members were divided into five rank groups; junior enlisted (E1-E4), senior enlisted (E5-E9), warrant officers (WO1-WO2), junior officers (O1-O3) and senior officers (O4-O10).

The SF-36 is a survey of patient health composed of 36 questions, organized in 8 dimensions being physical functioning (PF), social functioning (SF), role limitations due to physical health problems (RP), role limitations due to emotional problems (RE), general mental health (MH), vitality (VT), bodily pain (BP), and general health perceptions (GH). These multi-item dimensions are the weighted sums of the questions in their section. All scales are directly converted into a 0–100 scale where zero is maximum disability and 100 reflects no disability. The SF-36 is a measure of health status, commonly used in health economics as a variable in the quality-adjusted life year calculation to determine the cost-effectiveness of health treatment. In this study the Dutch validated version was used [35].

Based on the EuroQol-5D [36], the EQ-6D questionnaire is an instrument designed to measure health-related quality of life and health preferences using six dimensions. For each dimension, there are three possible answers (scoring from 1 to 3); no problems, some problems and extreme problems. The dimensions used are (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, (5) anxiety/depression, and (6) cognitive functioning. To score the current health status, the query ends with a visual analogue scale for self-related health state (VAS) ranging from 0 (worst state) to 100 (best state). The EQ-6D has been validated for usage in a Dutch population [37].

The 20 questions used in the LEFS consider daily activities that require functioning of the lower extremities. Participants are asked to score their ability to perform these activities in a scale from 0 (extreme difficulty or unable to perform activity) to 4 (no difficulty). Eventually a LEFS sum-score is calculated by the sum of the individual scores.

Statistical software (SPSS, Version 23, IBM Corporation, Armonk, New York) was used to study the relation of lower extremity injuries with functional outcome and quality of life, and to identify differences in outcomes between BCs and NBIs, and between patients treated with limb salvage surgery or amputation. Finally, the relation between pain and outcome scores was determined. Because of skewed distribution and number of participants less than 100, we used the Mann-Whitney *U* test to analyze continuous values and the Spearman's rank correlation coefficient (Spearman's ρ) for non-continuous variables. A *p*-value equal or less than 0.05 was considered statistically significant.

This study was approved by the Institutional Review Board of Leiden University and the Ministry of Defense, The Netherlands.

Results

In total, 84 service members had been evacuated out of theater after sustaining battle injuries or non-battle injuries that included any damage to the lower extremity. Sixty-seven percent (56/84) of these service members were considered BCs. Response rate for the online survey was 62% (34/55) for the BCs (one casualty could not be invited for the survey) and 46% (13/28) for the NBIs. Of these responders, the majority was male (96%), ranked junior enlisted (51%) or senior enlisted (34%) and had a profession within an infantry unit (66%, marines included). Questionnaires where answered on average 5 years after sustaining injury. In total 13 respondents had a serious lower extremity injury (AIS extremity