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Background: The injury pattern from improvised explosive device (IED) trauma is different if the target is in a vehicle (mounted) or on foot (dismounted). Combat and civilian first response protocols require the placement of a cervical collar on all victims of a blast injury.

Methods: We searched the Joint Theatre Trauma Registry (JTTR) and the Role 3 Hospital, Kandahar Airfield (KAF) database from Mar. 1, 2008, to May 31, 2011. We collected data on cervical fracture; head injury; traumatic amputation; initial blood pressure, pulse, injury severity score (ISS), Glasgow Coma Scale (GCS) score and base excess; and patient demographic information.

Results: The concordance rate between JTTR and KAF databases was 98%. Of the 15 693 admissions in JTTR, 326 patients with dismounted IED injuries were located. The rate of cervical collar prehospital placement was 7.6%. Cervical fractures were found in 19 (5.8%) dismounted IED victims, but only 4 (1.2%) were considered radiographically unstable. None of these 19 patients had prehospital placement of a collar. Patients with cervical spine fractures were more severely injured than those without (ISS 18.2 v. 13.4; GCS 10.1 v. 12.5). Patients with head injuries had significantly higher risk of cervical spine injury than those with no head injury recorded (13.6% v. 3.9%). No differences in frequency of cervical spine injury were found between patients who had associated traumatic amputations and those who did not (5.4% v. 6.0%).

Conclusion: Dismounted IED is a mechanism of injury associated with a low risk for cervical spine trauma. A selective protocol for cervical collar placement on victims of dismounted IED blasts is possible and may be more amenable to combat situations.

Contexte : Le type de blessures infligées par un engin explosif improvisé (EEI) est différent selon que la cible se trouve à l'intérieur d'un véhicule ou qu'elle circule à pied. Les protocoles de première intervention en zone de combat et auprès des populations civiles prévoient la pose d'un collet cervical chez toutes les victimes d'une blessure causée par une explosion.

Méthodes : Nous avons interrogé le JTTR (Joint Theatre Trauma Registry – Registre des traumatismes liés au théâtre des opérations conjointes) et la base de données de l'hôpital de Rôle 3 de la base aérienne de Kandahar (BAK) entre le 1er mars 2008 et le 31 mai 2011. Nous avons recueilli des données sur les fractures cervicales, les traumatismes crâniens, les amputations post-traumatiques, la tension artérielle initiale, le pouls, l'indice de gravité des traumatismes (IGT), le score à l'échelle de Glasgow (SG) et l'excès de base (gazométrie), de même que les caractéristiques démographiques des patients.

Résultats : Le taux de concordance entre les bases de données du JTTR et de la BAK était de 98 %. Parmi les 15 693 admissions au JTTR, on a recensé 326 patients victimes de blessures causées par un EEI qui circulaient à pied. Le taux de pose de collet cervical préhospitalisation était de 7,6 %. Des fractures cervicales ont été observées chez 19 (5,8 %) des victimes d'EEI qui circulaient à pied, mais seulement 4 (1,2 %) étaient considérées radiographiquement instables. Aucun de ces 19 patients n'avait reçu de collet cervical avant l'hospitalisation. Les patients atteints d'une fracture cervicale étaient plus gravement blessés que les autres (IGT 18,2 c. 13,4; SG 10,1 c. 12,5). Les patients victimes d'un traumatisme crânien étaient exposés à un risque significativement plus élevé de traumatisme cervical comparativement aux patients qui n'avaient pas de traumatisme crânien (13,6 % c. 3,9 %). On n'a observé aucune différence dans la fréquence des traumatismes cervicaux selon que les patients avaient ou non subi une amputation post-traumatique associée (5,4 % c. 6,0 %).

Conclusion : Les blessures causées par un EEI chez une personne qui circule à pied sont associées à un risque faible de traumatisme cervical. Il serait possible d'adopter un protocole sélectif de pose de collet cervical chez les victimes d'EEI qui circulent à pied, ce qui pourrait être mieux adapté aux situations de combat.

In recent conflicts, blast injuries from improvised explosive devices (IEDs) are the most common form of serious trauma.[1] A recent review of combat-related IED injuries reported an associated spine fracture rate of 8%.[2] The Joint Theatre Trauma System (JTTS) publishes clinical practice guidelines (CPGs) concerning common injuries encountered in a combat zone. The cervical spine (C-spine) CPG addresses the indication for placement of a cervical collar, requiring its use on all patients injured by any explosive mechanism.[3] The CPG's other indications for prehospital placement of a cervical collar are similar to those of civilian protocols, including trauma with loss of consciousness, falls from a height, motor vehicle accidents and vehicle rollovers.[4,5] However, there are substantial obstacles to the placement of a cervical collar or use of other forms of spine immobilization in the combat setting.[6] Indeed, in our experience over multiple deployments to Afghanistan between 2008 and 2012, very few casualties arrived at the North Atlantic Treaty Organization Role 3 Multinational Medical Unit (R3-MMU) in Kandahar Air Field (KAF) from the point of injury with complete cervical spine precautions. In the civilian arena, controversy exists regarding the universal use of cervical collar immobilization in conscious patients. No evidence exists to support or reject the use of a collar.[7] There is concern that cervical collar placement can, in some circumstances, cause harm.[8]

During this period of deployment, the JTTS CPGs also required all patients with IED blast injuries to undergo computed tomography (CT) of the head, face, neck, chest, abdomen and pelvis to clear the spine of fractures and the body of occult fragment injury.[3,9] This provided us with an opportunity to undertake a performance improvement project regarding the care of dismounted victims of IED blasts to clarify the proper priority for spinal precautions. Blast injuries from IEDs can be divided into 3 types: mounted, dismounted and crowd attacks, in which the targets of the attack are a vehicle (mounted), a person on foot (dismounted) or a crowd of people, respectively. Different patterns of injury are expected in each of these situations. Mounted IED attacks produce injuries similar to high-energy motor vehicle accidents. Crowd attacks, such as the Boston Marathon bombing, result in a wide spectrum of injuries. A dismounted IED attacks an individual on foot by targeting them with a trigger device or by radio-controlled detonation under observation. We wished to investigate dismounted IED injuries because of their prevalence in recent conflicts.

Methods

We queried the Joint Theatre Trauma Registry (JTTR) and the KAF patient tracking database for patients by filtering for blast injuries incurred as dismounted victims of IEDs. Data from a subset of patients over 18 months were compared for concordance between the 2 databases, whose entries were performed by different personnel. We searched the database for injuries recorded between Mar. 1, 2008, and May 31, 2011; the start date was selected as this is when a distinction between mounted and dismounted victims was first recorded in the JTTR. All services and nationalities were included except local nationals under the age of 16 years, pregnant women and detainees. The incidence of C-spine fractures was the primary outcome variable and was determined by searching for ICD-9 codes 805.01–805.07 and codes 805.11–805.17. We also extracted data on the presence of head injury (ICD-9 codes 800–802, 873.63, 873.73 and 959.01), initial blood pressure and pulse, injury severity score (ISS), Glasgow Coma Scale (GCS) score, base excess values, nationality, service and treating hospital. All cervical fractures were diagnosed or confirmed using CT. Fractures were determined to be unstable if 1 of the following signs was present: bilateral interfacetal dislocation, teardrop fracture (flexion or extension), wedge fracture with posterior ligamentous rupture, odontoid fracture (type II), Hangman's fracture or burst fracture (e.g., Jefferson fracture). Spinal cord injury was diagnosed clinically. Magnetic resonance imaging was not available.

The study was approved by the Commanding Officer of the R3-MMU, KAF, and by the Research Ethics Board of Western University.

Statistical analysis

Data are presented as means ± standard deviations, and we analyzed the data using Microsoft Excel. The Student *t* test was used to determine significant differences in population parameters, and the χ^2 test was used to determine association in categorical variables between 2 populations. We used a χ^2 distribution table with 1 degree of freedom and a probability level of 0.05 to reject or accept association.

Results

A total of 326 victims of dismounted IED blasts were identified among 15 693 admissions in the JTTR during our study period. Of these, 19 (5.8%) patients were found to have C-spine fractures. Only 4 (1.2%) patients were considered radiographically to be unstable. Coalition military force personnel accounted for 18 of the 19 patients with cervical fractures, while 1 was a local national. The average ISS for all patients with dismounted IED injuries was 13.7, and the average GCS score was 12.3. The patients with a C-spine fracture had a significantly higher mean ISS than those without a C-spine fracture (18.2 ± 11.4 v. 13.4 ± 11.8, $p = 0.039$). The patients with a C-spine fracture had a significantly lower mean GCS score than those without a C-spine fracture (10.1 ± 5.7 v. 12.5 ± 4.5, $p = 0.041$). The mean arterial pressure (92 mm Hg) and base deficit (–1.75 meq/L) did not differ between the groups.

The number of patients with traumatic amputations of the limbs totalled 96 (29%). C-spine fractures were found only in those who lost lower limbs. There were 5 C-spine fractures in 92 patients with lower-extremity traumatic amputations (5.4%). Four patients had isolated traumatic amputations of the upper limbs and 8 had a combination of both, but no patients in either of these groups had C-spine fractures.

Of the 326 patients in this study, 66 were reported to have injuries to the head and neck, yet only 9 (13.6%) of the patients with blunt or penetrating injuries to the head and neck were found to have a C-spine fracture. Of the 19 patients with C-spine fractures recorded in this study, 10 (52.6%) did not report or have clinical signs of a head or neck injury. When reviewing prehospital placement of a protective cervical collar, we found that only 6 of the 66 (9.1%) patients with head and neck injuries had them applied. Four of these patients had open skull or facial fractures, but 1 had only a broken nose and 1 had only a broken tooth. Of the patients in whom C-spine fractures were ultimately diagnosed, none received cervical collars in the prehospital setting. The total number of patients who had collars placed before arriving to the trauma bay was 25 (7.6%).

The radiographic diagnoses of C-spine fractures for 18 of the 19 patients were provided. Four (22.2%) of these were considered unstable based on radiographic criteria, including pedicle fracture ($n = 2$); multiple, 3-column fracture ($n = 1$); and body fracture with tearing of ligament ($n = 1$). Stable fractures included transverse process ($n = 5$), laminar fracture ($n = 3$), spinous process ($n = 2$), anterior chip ($n = 1$), end-plate ($n = 1$), facet ($n = 1$) and lateral peripheral fracture ($n = 1$). None of the patients with a radiographically unstable C-spine fracture had either a spinal cord injury or progression to a spinal cord injury.

Our comparison of data entry between the JTTR and the KAF databases showed a concordance rate of 98%.

Discussion

Modern conflicts involve more unconventional warfare than in the past with changing profiles of injury.[1,10] Insurgents resist efforts to stabilize a country through the use of terror and ambush operations. Buried home-made explosives meet their objectives by restricting movement and demoralizing the population. Both military and civilian populations are at risk of these attacks. The victims of dismounted IEDs in this series received wounds so devastating many would have been fatal were it not for the immediate attention of combat field medics and rapid evacuation from the point of injury. One-third of the victims had traumatic amputations. The blasts that these patients receive impart enough energy to raise concern for injury to the C-spine. This is the reason behind the CPG to apply a cervical collar to all victims of an explosive injury. Despite the recommendations of the CPG, we verified that only a minority of patients (8%) had a collar placed by first responders. Even among known high-risk patients, dismounted IED victims with head injuries, only 9% had a collar placed at the point of injury. Combat-related spine injuries can have serious consequences.[11] However, none of the patients with C-spine fractures in this report had a collar placed. Factors related to the circumstances of combat rather than the clinical factors are likely responsible for the low rate of compliance with the CPG.[6]

The incidence of C-spine fracture is very low in patients with dismounted IED injuries, even when the blast is severe enough to traumatically amputate an extremity. There was no history or clinical evidence of a C-spine injury in almost half of the patients with a C-spine fracture, whose diagnoses were made on screening imaging. On the other hand, concomitant head injury increased the risk of C-spine fracture 4-fold, confirming an observation that was known in civilian practice. A minority of C-spine fractures were radiographically unstable. These findings are very similar to those reported in a series of civilian trauma patients[12] where the universal application of cervical collars in conscious patients has been questioned.[7,8]

These data suggest that a selective protocol for application of a cervical collar to victims of dismounted IED blasts would be possible. The Canadian C-spine rule was developed as a structured approach to rapidly clear the C-spine by the selection of civilian trauma patients for CT imaging.[13] The C-spine rule has been shown to be superior to other selection protocols and has become the standard in emergency departments.[14] It has since been applied to the prehospital setting.[15] The C-spine rule combines factors related to the patient, the mechanism of injury and clinical factors to determine those at risk for a C-spine fracture. According to the rule, in traumas from a low-risk mechanism of injury, patients younger than 65 years who are alert, ambulatory or sitting up and who have no pain or tenderness of the neck, or who voluntarily rotate their heads do not require imaging.

Conclusion

Our data suggest that a dismounted IED is a mechanism of injury with a low risk for neurologic injury. Targets of a dismounted IED who are alert, who have sat up or walked since the injury and who spontaneously move their necks may not require cervical collar placement. This will have important implications for combat first responders who often have to carry their own supplies; the space used by extra cervical collars can be usefully redeployed. On the other hand, our data confirm the universal use of screening CT in patients with dismounted IED trauma because clinical examination did not predict the presence of C-spine fractures and because of its use to diagnose occult fragment injury.

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