Learning the lessons from conflict: Pre-hospital cervical spine stabilisation following ballistic neck trauma

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ABSTRACT

Background: Current ATLS protocols dictate that spinal precautions should be in place when a casualty has sustained trauma from a significant mechanism of injury likely to damage the cervical spine. In hostile environments, the application of these precautions can place pre-hospital medical teams at considerable personal risk. It may also prevent or delay the identification of airway problems. In today’s global threat from terrorism, this hostile environment is no longer restricted to conflict zones. The aim of this study was to ascertain the incidence of cervical spine injury following penetrating ballistic neck trauma in order to evaluate the need for pre-hospital cervical immobilisation in these casualties.

Methods: We retrospectively reviewed the medical records of British military casualties of combat, from Iraq and Afghanistan presenting with a penetrating neck injury during the last 5.5 years. For each patient, the mechanism of injury, neurological state on admission, medical and surgical intervention was recorded.

Results: During the study period, 90 casualties sustained a penetrating neck injury. The mechanism of injury was by explosion in 66 (73%) and from gunshot wounds in 24 (27%). Cervical spine injuries (either cervical spine fracture or cervical spinal cord injury) were present in 20 of the 90 (22%) casualties, but only 6 of these (7%) actually survived to reach hospital. Four of this six subsequently died from injuries within 72 h. Only 1 (1.8%) of the 56 survivors to reach a surgical facility sustained an unstable cervical spine injury that required surgical stabilisation. This patient later died as a result of a co-existing head injury.

Conclusions: Penetrating ballistic trauma to the neck is associated with a high mortality rate. Our data suggests that it is very unlikely that penetrating ballistic trauma to the neck will result in an unstable cervical spine in survivors. In a hazardous environment (e.g. shooting incidents or terrorist bombings), the risk/benefit ratio of mandatory spinal immobilisation is unfavourable and may place medical teams at prolonged risk. In addition cervical collars may hide potential life-threatening conditions.

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Introduction

The issue of pre-hospital stabilisation of the cervical spine for penetrating trauma of the neck has been a subject of considerable debate in recent years. Current Advanced Trauma Life Support® (ATLS) guidelines recommend “any patient with a suspected spine injury should be immobilised above and below the suspected injury site until a fracture is excluded by X-rays. … Cervical spine injury requires continuous immobilisation of the entire patient with a semi-rigid cervical collar, head immobilisation, backboard, tape, and straps before and during transfer to a definitive-care facility”.1 The aim of cervical immobilisation is to prevent further damage to the spinal column in unstable injuries. Harrop et al. reported an incidence of 6% of patients who experience a deterioration of neurological symptoms following acute cervical spinal cord injury.13

Spinal immobilisation is time-consuming and requires specialist equipment to be applied correctly. C-spine immobilisation requires a minimum of 2 paramedics to apply and at least 4 people to perform a log-roll or to carry the immobilised patient. Arishita et al., timed experienced emergency medical technicians to adequately immobilise the cervical spine during a unit training exercise and found that the mean time for C-spine immobilisation was 5.64 min (±1.49 min).4

Following terrorist bombings, the tactical situation more closely resembles the environment previously restricted to conflict
zones. First responders to terrorist events are at risk from secondary terrorist attacks and from collapsing infrastructure. Applying spinal immobilisation can leave pre-hospital teams exposed for considerable periods of time and can tie up a significant number of personnel. During the 9/11 attacks in New York, 450 first responders died at the World Trade Centre.

Prolonged time spent at the incident can place pre-hospital teams at increased personal risk.

With the current global security climate, the types of weapons encountered in combat operations can be equally encountered in civilian incidents. The aim of this study was to ascertain the incidence and severity of cervical spine injury following penetrating ballistic neck trauma on military operations, in order to inform on the risk/benefit ratio of pre-hospital cervical immobilisation in these cases.

Methods

Ethical approval for this study was obtained from the local ethics review board. A previously established computerised registry (Joint Theatre Trauma Registry, JTTR\textsuperscript{20}), of all UK military trauma casualties admitted to coalition medical facilities on military operations in Iraq and Afghanistan from 2003 to 2008, was used to identify subjects with penetrating injury to the neck as a result of hostile action.

For casualties suffering a fatal injury, killed in action (KIA) was defined as those fatalities that had died prior to arrival at a medical treatment facility and died of wounds (DOW) were those who died after arrival at a medical treatment facility.\textsuperscript{14}

From the medical documentation, data was collected on the (i) mechanism of injury (explosive or gunshot wound, GSW), (ii) neurological status on admission to the field hospital, (iii) level of consciousness as measured by the Glasgow Coma Scale, (iv) any associated injuries, (v) initial management at the field hospital, (vi) any subsequent management on evacuation back to the UK.

Results

During the study period, there were 90 casualties who sustained penetrating trauma to the neck from hostile action. A flow diagram of the study population is represented in Fig. 1. Explosions resulted in 73% of casualties and GSW 27%. Those casualties injured by explosion had a statistically significant higher percentage of survivors compared to those wounded by GSW (52\% vs. 25\%, Fishers exact two-tailed value, p = 0.03).

None of the 43 casualties who survived to reach a medical facility without a cervical spine injury presented with any focal neurological deficit or diminished level of consciousness.

Twenty of the 90 casualties (22\%) sustained an associated cervical column injury. The mechanism of injury is represented in Table 1. There were no cases where there was a combined penetrating and blunt mechanism of injury. There was a statistically greater incidence of cervical column injuries in the GSW group compared to the explosion group (46\% vs. 14\%, Fisher's two-tailed value, p < 0.01). Eighteen of these 20 casualties (90\%) died from their injuries.

Fourteen of the 20 casualties with a cervical spine injury (70\%) had an associated major vascular injury in the neck. None of the casualties who sustained either a major vascular injury or a cord transection survived. Injury to the spinal cord (either contusion or transection) was noted in 16 of the 20 (80\%).

Six casualties (12\% of the 20) with cervical column injuries survived to reach a surgical facility. All six patients presented with either an altered mental status or a focal neurological deficit. Of the six, four DOW and of these four, three had unstable cervical spine injuries. One of these three sustained a GSW to the neck, resulting

in an unstable multiligamentary fracture of the body of C2, C3 and a partial transection of the cord at that level. He was in cardiac arrest on arrival, but was resuscitated and transferred to a neurosurgical centre for HALO stabilisation. He died 3 days later from a brainstem injury. The two remaining survivors both suffered stable fractures of the cervical spine and did not require surgical stabilisation. One sustained a fracture of the spinous process and arch of C3 with bone fragments within the spinal canal from fragmentation wounds. He was fully conscious but had a monoplegia. He was immobilised in hospital and underwent spinal decompression on arrival in the UK. The cervical spine fracture was considered stable at operation. The second patient sustained a single GSW to the neck with a fracture of the spinous process of C5 with severe contusion of the cervical cord C3–C7. He developed an incomplete tetraplegia, but the cervical spine was considered stable and the patient was treated conservatively.\textsuperscript{12}

Discussion

The overall incidence of cervical spine injury following penetrating ballistic neck trauma in our study was 22\% (20/90), 70\% (14/20) of those with a cervical injury died at the scene of the incident. This figure is significantly higher than the 26\% mortality reported in civilian cervical spinal cord injuries.\textsuperscript{11} This illustrates the severity of cervical spine damage and associated injuries that frequently occur in combat injuries. The incidence of cervical spine injuries in survivors was only 12\% (6/49) with only 2 casualties (4\%) surviving past the initial resuscitative phase. This figure is lower than those reported previously in civilian studies. Ordog et al. found cervical spine fractures in 24 patients (22\%) in a review of 110 gunshot wounds to the neck.\textsuperscript{18} Medzon et al. reported the overall rate of cervical spine fracture was 23\% after gunshot wounds to the head or neck.\textsuperscript{17} This difference in incidence is likely to be related to the energy transfer involved with military weapons and the higher associated mortality.

High-velocity military projectiles have the potential to transfer more energy to tissues than lower velocity projectiles usually seen in civilian trauma, although this will vary depending on the range at which a weapon is fired, the speed and mass of the projectile and the effect of any intervening structures encountered by the projectile. Our findings are very similar to Arishita et al. who reviewed the Wound Data and Munitions Effectiveness Team (WDMET) database containing 4555 patients injured in Vietnam from 1966 to 1969. In the 472 penetrating neck injuries seen, only 11 (3.7\%) of the 296 survivors had cervical spine injuries.\textsuperscript{4}

Currently, data from the UK does not provide information about the incidence of cervical spine injuries from the type of weapons seen in terrorist or shooting incidents. Connell et al. analysed the Scottish Trauma Audit Group (STAG) database from 1992 to 1997, and out of 34,903 cases, found only 5 instances of cervical spinal cord injury from penetrating neck trauma, with only 1 case resulting from a gunshot wound (GSW).\textsuperscript{5}

It is believed that movement of the non-immobilised patient with an unstable vertebral column injury places the spinal cord at risk of primary or worsening damage. Harrop et al. reported an incidence of 6\% of patients who experience a deterioration of neurological symptoms following acute cervical spinal cord injury, but they also reported no cases of deterioration in patients with penetrating cervical spine injury.\textsuperscript{13} It is generally agreed that injuries in which the column remains stable or there is a complete cord injury will not benefit from neck stabilisation.\textsuperscript{5}

Our data found only 3 (3.3\%) casualties with an unstable cervical spine who survived to reach a surgical facility; 2 died shortly after admission to hospital. Only 1 (1.8\%) of the survivors may have benefited from cervical immobilisation and his intra-operative findings suggested that his cord injury was sustained at
the time of wounding rather than secondary to being moved without immobilisation. He died from associated brainstem injuries 3 days after surgical stabilisation. This is corroborated by further analysis of the cases from the WDMET database, which showed that only 4 casualties (1.4%) might have benefited from pre-hospital cervical stabilisation. The authors recommended that in combat conditions, it was neither prudent nor practical to immobilise all patients with penetrating injury to the neck under battlefield conditions.

Injuries during conflict to those providing care to casualties is not uncommon and in the Vietnam conflict, up to 11% of casualties were personnel injured while assisting another casualty. Time taken with unnecessary procedures in a danger area increases the risk to both the carer and the casualty. Although the civilian environment is not the same as the conflict environment, there are specific situations where a heightened consideration of threat is needed. Terrorist attacks in several countries have shown deliberate targeting of first responders by placement of secondary explosives. The development of expanding haematoma, tracheal deviation, subcutaneous emphysema and diminished or absent carotid pulsation are indicators of impending obstruction of the airway or life-threatening conditions. Barkana et al., reported 8 cases out of 44 patients (22%) where life-threatening signs were found after penetrating neck trauma. The threat environment dictates the level of care possible. BATLS categorises initial care as (1) Care Under Fire or (2) Tactical Field Care. Care under Fire, refers to the immediate management of the casualty during hostile action. The priority during this phase is to get the casualty out of the danger and to treat life-threatening injuries once cover from danger is found. Therefore, rapid extraction from danger takes priority over formal cervical spine immobilisation. Tactical Field Care can occur when the immediate threat has passed although the environment is at best ‘semi- permissive’ and the situation can change quickly. The aim is to do the minimum to ensure safe transfer to the next level of care. Even in this semi-permissive state, the tactical situation may not allow an opportunity to apply cervical immobilisation.

A potential weakness of this study is that we focused purely on penetrating ballistic neck trauma. It is important to recognise that blunt trauma to the neck can also be caused by explosions. Expansion can cause injury by a number of mechanisms including penetrating trauma from secondary blast injury and bodily displacement of casualties thrown by the blast wind (tertiary blast injury). In addition, casualties may be ejected from vehicles or from roll-overs. In these circumstances, where a casualty has suffered significant blunt trauma then cervical immobilisation should be considered, although this practice may need to be modified according to the tactical situation and prevalent threat at scene. Our data did not reveal any cases of combined penetrating and blunt trauma to the neck. Hospital personnel do need to be aware of the circumstances on the ground and may wish to start, maintain or discontinue immobilisation following reassessment and imaging of the patient.

Our data also showed that ballistic cervical spine injuries were only seen in patients with focal neurological signs or diminished levels of consciousness. This finding is in keeping with other studies that indicate that the incidence of cervical spine injury in neurologically intact patients is very rare.

Conclusion

We conclude that the conventional teaching of cervical immobilisation following penetrating ballistic neck trauma may
only provide potential benefit to a very small proportion of patients.

We believe that in circumstances where medical teams are working in high risk ballistic environments, there is a need to diverge from standard clinical guidelines laid down by ATLS and British Trauma Society as the risk/benefit ratio is unfavourable for immobilisation following penetrating ballistic neck trauma.

Conflict of interest

We confirm that there are no conflicts of interest in relation to submission of this article.

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References