Protection Of The Spinal Cord During Stabilisation Of Vital Functions And Extrication Of Trauma Victims

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Citation

Abstract
Stabilisation of the spinal column in trauma victims is assumed to prevent spinal cord injury. We have developed a protocol for spinal stabilisation that includes the interaction between stabilisation of the vital functions and extrication of the victim. Trauma management according to this protocol will improve co-operation between rescuers and will guide decision-making.

INTRODUCTION
Injuries of the spine are serious injuries, which cause disabling conditions ranging from minor pains to quadriplegia and death. Both the physical and emotional impact of the injury disturb the lifestyle of the individual and his family. The financial consequences for society, caused by disability and unemployment, are estimated at one million US$ per patient.\(^1\)\(^-\)\(^3\)

Spinal cord injury occurs at an annual rate of 20-50 persons per million population. In the Netherlands (15 million population) trauma causes permanent spinal cord injury in 500-600 victims every year. The major causes of spinal injuries in order of frequency are motor vehicle accidents, falls and sport accidents including diving into shallow water.\(^2\) More than 50 percent of patients are under 35 years of age.\(^4\)

It has been suggested that 25% of all permanent spinal injuries are caused by improper extrication, transport and handling of trauma victims by health professionals.\(^5\)

Stabilisation of the spinal column may prevent exacerbation of spinal cord injury during the extrication and initial medical treatment of trauma victims, especially in victims who have injury to the spinal column but have no injury to the spinal cord.

Stabilisation of the spinal column at the scene of an accident is not an easy task: many rescuers of ambulance services, fire brigade and police are involved. Furthermore, stabilisation of the spinal column always interferes with stabilisation of vital functions and with extrication of the victim.

The structural approach of a protocol enables smooth co-operation between rescuers and uniform prioritisation. We have developed such a protocol for spinal stabilisation.

THE PROTOCOL
Figure 1 shows our protocol for spinal stabilisation. The following phases may be recognised.
Fig. 1: Indications and protocol for spinal stabilisation in trauma victims.

PRIMARY SURVEY AND STABILISATION OF THE VITAL FUNCTIONS

Stabilisation of the vital functions has to occur in a systematic way. Airway, Breathing and Circulation are judged and measures are taken to stabilise them. While the airway is assessed, the cervical spine is moved into neutral in-line position. In this position the spinal canal has been shown to give most space to the spinal cord. Furthermore, the neutral position is the most stable position of the cervical spine. Movement of the head toward neutral position should be stopped immediately if it results in increase in pain, neurological deficits or neck muscle spasm. When these signs occur, the head of the patient should be stabilised in the position in which it was initially found.

A helmet should be removed by means of a technique that ensures continuous stabilisation of the cervical spine.

IMMOBILISATION BEFORE EXTRICATION: THE CERVICAL COLLAR AND THE SPINE SPLINT

After stabilisation of the vital functions and a secondary survey the ambulance crew has to decide whether or not additional immobilisation of the spine is needed and which devices should be used. Indications for additional stabilisation are tenderness or deformity of neck or back, altered level of consciousness, neurologic deficits and high-energy trauma. The protocol assumes the availability of rigid cervical collars (fig. 2) and a spine splint (fig. 3) for spinal stabilisation in the initial phase.

Fig. 2: Set of rigid cervical collars (Stiffneck®). This set contains two sizes for children and four for adults. (reproduced with permission)

A cervical collar rests on the shoulder girdle and supports the mandible and the occiput, thereby contributing to the maintenance of the neutral position of the head and cervical spine. Rigid collars have more immobilising capacity compared to soft or semirigid (Philadelphia) collars.

5c-e), To establish an open airway while the cervical spine remains in neutral position the chin-lift or jaw-thrust manoeuvre should be used.

After the head is positioned in the neutral position, it has to remain in this position until application of stabilising devices.
The immobilising capacity of all collars is restricted. Additional manual stabilisation remains necessary until the head is secured to a spine splint (fig. 6f) or head immobilising pillow (fig. 5f).

Effective immobilisation of the cervical spine and limited stabilisation of the thoracic and lumbar spine is achieved by using a spine splint (fig. 3). A spine splint consists of wooden strips moulded into a vest that is fixed against the back of the victim. In most adults, padding between the back of the patient’s head and the headpiece of the device is required to maintain neutral alignment of the cervical spine. The amount of padding needed differs from person to person and varies between 0-9.5 cm. This depends on the musculoskeletal development of the shoulder girdle. After the torso has been immobilised and appropriate padding has been placed behind the head, the head is immobilised against the device.

The head of a child is larger in relation to the rest of the body than the head of an adult. When the head of a small child is in the neutral in-line position, the back of the head is 0.5-4 cm posterior of the outermost aspect of the back. If the child is placed on a flat surface, the head is forced into flexion. Neutral alignment of the head, neck and thorax requires padding under the child’s torso.

Whether or not to use a spine splint depends on the need of rapid extrication and on the position of the victim. Simple measures like manual stabilisation of the head or application of a cervical collar do not delay stabilisation of the vital functions. However, the application of a spine splint takes up to five minutes. If the vital functions can not be stabilised adequately, this device should not be used. Rapid extrication is indicated.

The position of the victim determines how much manipulation will be caused by application of the splint. The ambulance nurse has to weigh the movements of the victim’s spine during its application against the movements prevented by the splint after its application. It is difficult to give rules for this weighing. In general, victims of a motor vehicle accident should be immobilised using a spine splint while sitting in their vehicle. Thereafter extrication from the vehicle can be performed with little movement of the spine. When a victim lies on a flat surface a spine splint should not be used.

**EXTRICATION AND TRANSPORT**

Victims who may have spinal injury should be transported in the supine position. This is the most stable position for the thoracic and lumbar spine. It also facilitates further examination and treatment of the patient.

To move a sitting patient, for example from a vehicle, a backboard (fig. 4) is used. A backboard is a person-long plastic or wooden rigid board, on which the victim is fixed in such a manner that movements of the spine are prevented. The rescuers shift the victim longitudinally, i.e. in the direction of his spine, onto the backboard. This technique prevents lateral flexion and rotation of the spine.

Supine victims, lying free from obstacles on a flat surface, should be placed onto the ambulance stretcher using a scoop stretcher (fig. 4). A scoop stretcher is an aluminium stretcher consisting of two parts which can be assembled underneath the victim. Moving a victim using the logroll has been shown to cause potentially dangerous movements in an unstable spine.
However, to move a patient lying prone or on his side to the supine position a modification of the logroll is used. At least four persons are needed to turn the victim smoothly while keeping the spine aligned. Next, a scoop stretcher or backboard is used to prevent additional injury.

**Figure 4**
Figure 4: a. scoop stretcher, b. long backboard. (reproduced with permission27)

Once moved onto a stretcher, vacuum mattress or backboard, the victim should be fixed using straps and/or tape.7; 16; 24

**CASE REPORTS**
The following case reports illustrate the use of the protocol.

Victim A is a motorcyclist who lost control of his vehicle and collided with a tree at the side of the road. The ambulance crew finds him about 30 meters away from the tree lying on his side. He has not been moved. He is wearing a helmet.

The victim is turned to the supine position using the modified log roll.

**Figure 5**

Four rescuers keep the victim’s spine aligned while turning him. The cervical spine is moved into neutral position and kept in this position after turning.

**Figure 6**

The helmet is removed, using the technique shown here. This technique ensures continuous stabilisation of the cervical spine.

It is quite easy to put a victim, who is on a scoop stretcher, upon a vacuum mattress. After inducing the vacuum, the mattress becomes rigid and supports the spine of the victim uniformly.
The victim is unresponsive. It is not possible to create a patent airway using the jaw thrust or chin lift manoeuvre. The victim is intubated, while the head is kept in neutral position.

The heart rate is 130 bpm and blood pressure 90/50 mmHg. Two large bore intravenous needles are inserted. A secondary survey reveals no clear explanation for the patient’s shock.

Signs of spinal injury such as pain and neurological deficits cannot be assessed in coma. Spinal injury has to be assumed because the victim has sustained a high-energy trauma.

First a cervical collar is applied. To keep the head of the victim in neutral position and to prevent rotation and lateral bending of the neck a head immobilising pillow is used.

A scoop stretcher is adjusted to the victim’s height and the victim is scooped.

The victim is lifted onto an ambulance stretcher prepared with a vacuum mattress.

Before inducing the vacuum, the scoop stretcher is removed. The victim is fixed to the mattress using straps and transported to a specialised trauma centre. There, immobilisation of the spine is continued until spinal injury is excluded.
Victim B. A 30-year-old male is the driver and sole occupant of a car that went off the road at approximately 70 kilometres per hour. He is sitting behind the steering wheel, trapped under the dashboard (fig. 6a). The fire brigade stabilises the car by putting blocks under the frame and emptying the tyres.

The victim is confused. His head is moved into neutral in-line position and kept in this position manually (fig. 6b). He is breathing spontaneously at a rate of 30 breaths per minute. High-flow oxygen is delivered with a non-rebreathing mask. Breathing sounds are equal on the left and right lung fields. Heart rate is 120 bpm, blood pressure 120/80 mmHg. Major blood loss is not observed. Two large bore intravenous infusion needles are inserted.

A secondary examination reveals a fractured left clavicle, abdominal pain and a fractured right femur. There are no neurological deficits, but, because of the high-energy trauma, the patient may have spinal injuries.

A cervical collar is applied. Manual in-line stabilisation of the head is maintained after this. In the meantime 1500 ml crystalloid fluid has been infused and the patient’s pulse rate has dropped to 105 bpm. The patient seems in a stable condition and is not in need of rapid extrication. The fire brigade removes the door and the roof of the car (fig. 6c).

A spine splint is inserted between the victim’s back and the seat (fig. 6d).

First the straps around the torso are fastened. To maintain the neutral alignment, padding is placed behind the victim’s
head. Finally, the head is fixed to the spine splint. Manual stabilisation of the cervical spine is discontinued.

The seat is turned backwards. A long backboard is inserted between the seat and the back of the victim (fig. 6e).

**Figure 17**

While one-person keeps the backboard in position the victim is gradually shifted on it by five rescuers (fig. 6f, not all rescuers shown), one guiding the head, two the trunk and one each of the legs.

**Figure 18**

The legs are splinted and the victim is fixed onto the backboard using blankets, towels and straps. He is put onto an ambulance stretcher (fig. 6g) and transported to a specialised trauma centre. Cervical collar, spine splint and backboard do not restrict initial radiological survey.

**Figure 19**

**DISCUSSION**

In this paper we have presented a protocol for stabilisation of the spine in trauma victims. The protocol has been developed in the Netherlands, where medical care at the scene of most accidents is provided by autonomously working ambulance nurses, authorised to work according to protocols.

Although the differences in training and equipment within Europe are many, using protocols will improve co-operation between all kinds of rescuers.

Those, who have been trained in Advanced Trauma Life Support (ATLS®)8 or PreHospital Trauma Life Support (PHTLS®)26, will recognise the principles of continuous neutral in-line stabilisation of the spine. The main difference between the ATLS/PHTLS approach and our protocol concerns the use of scoop stretcher and spine splint. Our interpretation of current literature is that these devices should not only be regarded as alternatives for log-roll and backboard, but that there are defined indications for using them.

It is not difficult to imagine that unusual movements of an unstable spine may cause spinal cord injury. One retrospective study5 suggests that omitting spinal stabilisation causes (exacerbation of) spinal cord injury. As far as we known, studies comparing the incidence and seriousness of spinal cord injury between trauma victims whose spine have and have not been stabilised do not exist.

Our protocol is based on studies comparing different techniques and devices for spinal stabilisation.17-23 Most of them use radiological criteria to compare restriction of the range of movement of the cervical spine in healthy volunteers. There are almost no data about the immobilisation of unstable spines. Future research has to
focus on this subject.

We hypothesise that using this protocol for spinal stabilisation will improve outcome in trauma victims.

ACKNOWLEDGEMENT

We are indebted to J. Valk and R. Vos for their critical comments on the paper and to A. Buchthal for English language correction.

References

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