GUIDELINES FOR MANAGEMENT OF CERVICAL SPINE TRAUMA

Mihai Botea, Ioan Magyar, Dragoş Botea, Mircea Şandor
Oradea County Emergency Hospital, University of Oradea, str. Universităţii, nr.1
drmob78@yahoo.com

Abstract. This guideline is proposed by Emergency Unit of Oradea Clinic Emergency Hospital for discussion and consensus adoption of the following clinical specialties: emergency medicine, neurosurgery, ICU, radiology, orthopedics, general surgery. We intend that this material will be useful for the correct management of cervical spine (CS) injuries in the spirit of the concept "Evidence based medicine".
Development of this guideline aims to support the efforts to a standardized management and help physicians to be selective and rational in using imaging investigations without affecting in any way the quality of care.

INTRODUCTION

Management of cervical spine trauma is a chapter in trauma management and still a controversial area regarding optimal medical treatment. Missed cervical spine injury can have devastating consequences and could result in permanent disability to the patient. On the other hand, maintaining cervical immobilization collar unnecessarily for a longtime is associated with complications such as skin ulcers or bedsores. In most cases, patients are divided into two main categories: those who are conscious and can actively participate in the medical evaluation and those with impaired consciousness that medical evaluation is restricted.

Cervical spine trauma has an incidence of 3% of all patients with major trauma and increases up to 10% in patients with head injury (1.2). Up to 25% of patients with spinal trauma will also present with minor cerebral injury. Statistics presented in literature describes the distribution of trauma in the anatomical regions of spinal cord injuries as follows: 55% in the cervical region, 15% thoracic region, 15% thoraco-lumbar junction region, 15% lumbo-sacral region. Cervical spine is most vulnerable because it is mobile and is the most exposed region. *Approximately 10% of patients with fracture of the cervical spine have another fracture in a different location of the vertebral column.*

Neurological deficit is a common complication in cervical trauma and can result in devastating disabilities to the patient; socio-economic consequences for society cannot be neglected too. Failure to diagnose injuries results in delayed treatment. An unstable fracture of the cervical spine is at high risk of developing tetraplegia. It is therefore crucial that physicians responsible for the initial assessment and treatment of the trauma patients have necessary skills in management and quick diagnosis of cervical spine injuries, and also in assessing associated trauma.

As long as the patient's cervical spine is protected and stabilized, evaluation and exclusion of other injuries can be delayed, especially in the presence of hemodynamic and respiratory instability. From here it's mandatory to respect the ABC principle in primary and secondary evaluation of the trauma patient:

(A) Airway patency must be ensured and cervical spine immobilization as first step in emergency management.

(B) Evaluation and stabilization of Breathing

(C) Evaluation and stabilization of Circulation

Once a problem is identified during this any stage of the evaluation, we will not precede to the next step until a vital maneuver or procedure is considerably done.

PREHOSPITAL MANAGEMENT

In the prehospital management it's essential to recognize a possible spinal cord injury and the necessity to immobilize the spinal cord taking into account the mechanism of the trauma, the presence of pain in the vertebral column, the presence of neurological symptoms and the number of risk factors. These patients must be fitted with a cervical collar and should be transported on a stretcher or vacuum mattress. The patient can be placed on the stretcher from different position and is influenced by the type of the board (stretcher) available - this procedure is not an aim of this guideline.

It is important minimal mobilization using lateral movements of the longitudinal body axis using the technique of "log roll" (9).Patient should be immobilized on a stretcher in multiple attachment points (recommended at least six) both for safety and also to be able to rotate to 90 degrees in the event of vomiting - as the patient remains completely immobilized in a neutral position. Multiple trauma patients and spinal trauma patients, especially those patients who have neurological deficit should be transferred directly to the Level 1 Trauma Center if stable and the transfer time is reasonable (7).

MANAGEMENT IN EMERGENCY DEPARTMENT

Here we recall the evaluation and treatment of patients following the principles outlined above ABC.

In the initial phase the patient is best evaluated and treated in the supine position (perfectly horizontal). This immobilization is recommended to apply for both conscious and unconscious patient. If the patient is not positioned on a spinal board, immobilization on a standard hospital trolley can be accomplished by fixing the patients in a firm position and also immobilizing of the cephalic extremity. This consist of either using head blocks or use of any other head improvisations (rolled blankets or bags filled with sand to a side of the head) to be attached along with the patient's head to the stretcher/trolley by two

bands of tape - one that passes over the forehead and the second over chin (6). In a conscious patient the role of this procedure must be explained and also the importance of maintaining this position properly, at least until diagnosis is cleared by radiological imaging techniques. The patient may be uncooperative and agitated. This might be due to a brain injury associated to hypotension, pain or the patient can be under the influence of toxics. In this situation sedation can be considered only after analgesics were already administered ensuring the patient's comfort through adequate pain control. Use the "log roll" technique for entire spinal cord evaluation and clinical clearance in the safety conditions.

Stretcher or spinal board should be used only for transporting and transferring the patient. It should be removed as soon as possible. It is advisable that the patient doesn't stay on a stretcher for more than 2 hours. If this is not possible to move from the stretcher within 2 hours, the patient should be turned on one side while maintaining spine alignment every 2 hours, in order to reduce the risk of developing decubitus lesions (3). A standard hospital mattress provides adequate support for the spine (8).

Management of airway and breathing:

Ensure a clear airway and adequate ventilation - hypoxia will compromise more a spinal cord injury (5). In the initial phase of management in an unconscious patient is jaw thrust and suctioning of the upper airway, but carefully as oropharyngeal stimulation can cause bradycardia (5). Use of simple techniques to maintain an open airway such as oropharyngeal or nasopharyngeal airway may be taken into consideration but sometimes tracheal intubation is required (e.g. GCS $\leq$ 8). It is recommended to be performed using rapid sequence intubation (RSI) by maintaining the head in a neutral position by a helper. It is also recommended to prepare handy alternative advanced airway management techniques such as fibroscopy. The incidence of respiratory complications after a spinal cord injury is 60 %. It is important to perform a complete neurological evaluation, if possible, before the patient is sedated and intubated. *In situation in which the patient breathes spontaneously, ventilation may become damaged due to edema and/or ischemia of spinal cord, so it is important to assess the patient regularly to identify diaphragmatic respirations (diaphragm is innervated by nerves that start in region C3/ 4/5) or use accessory respiratory muscles.*

Cervical spinal canal is wider in the upper portions, beginning at foramen magnum and extends distally to the level of C2. The majority of the patients who survive with trauma at this level are presented to the emergency department without any neurological signs (3). Statistical studies show that approximately one third of patients with upper cervical spinal injury die at the site of accident due to central apnea caused by loss of control of the nerve that innervates the diaphragm and respiratory muscles. Below C3 spinal canal diameter is much smaller and vertebral injuries below this level are more prone to spinal cord injury (3). Emergency doctor must anticipate problems in airway management in a trauma patient with CS. Spinal cord injury above C3 causes paralysis of respiratory muscles, and injury below and adjacent to this level can cause respiratory complications by inflammation and edema which may ascend upwards and cause paralysis of the phrenic nerve. Tintinalli, in the latest edition of "Emergency Medicine" published under the American College of Physicians of Emergency Medicine, presents imperatively *"any patient with a lesion at C5 or above should be intubated"* (8) The concept ATLS (Advanced Trauma Life Support) promoted by the American College of Surgeons supports the idea that "*cervical spinal trauma over the C6 with involvement of myelitis can produce total or partial loss of respiratory function, and when there is a adequate ventilation concerns about the patient, then the patient should be intubated before transfer* "(3). Cervical spinal injury patients may be intubated precautionarily even if the lesion is located below this level. Significant edema can progress rostrally to the spinal cord and affect phrenic nerve roots. Many patients may initially have ventilation support using the intercostal muscles or by abdominal breathing, but eventually they get tired and then they develops respiratory failure (8).

Hall in the latest edition of "Principles of Critical Care" referring to airway management in patients with cervical lesion presents "is a trend that lung function deteriorates after the third or fourth day due to fatigue and accumulation of secretions, so intubation and ventilation could be considered as an early maneuvers "(7). Cervical spinal lesions were also associated with retropharyngeal edema or hemorrhage or severe maxillofacial trauma (6). It is also recommended to take into consideration of cricothyroidotomy in patients with severe facial injuries when SIR is contraindicated or when intubation failed (6). Pulse oximetry and blood gas determination will confirm adequate ventilation and oxygenation. It is important to ensure adequate ventilation for oxygenation of blood and optimal perfusion to the affected spinal cord, also administering supplemental oxygen to maintain a PaO2 of at least 100 mmHg (7).

Management of shock

Monitoring ECG and BP is essential. medullary lesion means interruption of the sympathetic nervous system, leading to loss of vascular tone in the walls of vessels distal to the lesion, causing vasodilation which results in decreasing of BP. Absence of reflexes and identification of a flaccid muscles, with bradycardia (without reflex tachycardia that occurs usually in hypovolemic shock - at least initially) argue for neurogenic shock. But before making this diagnosis other causes of hypotension such as hemorrhagic shock or tension pneumothorax (5) must be excluded. Given that the trauma to the spinal column is frequently associated with lesions in the other regions, careful examination must be made to exclude bleeding from other sources like chest, abdomen or pelvis fracture or long bone fractures. Set a high degree of suspicion for thoraco-abdominal trauma, especially in the context of a spinal injury when symptoms can be hidden due to sensory and motor deficits. Abdominal trauma in certain cases may manifest only as abdominal distension, peritoneal signs are masked, in this context paraclinical examinations can be of real help: FAST ultrasound, CT or peritoneal lavage (5). These investigations should be requested early as possible especially when a patient is hemodynamically unstable.

In conclusion hypotension may be due to bleeding and/or neurogenic shock.

Management of neurogenic shock vs. spinal shock:

Patients with *neurogenic shock*, especially that patient with medullary lesions above the T6, presents with hypotension and bradycardia due to a combination of factors such as sympathetic nerve-sparing loss, peripheral vasodilatation and blood stagnation and predominance of vagal stimulation of the heart (7) . Once bleeding is excluded as the cause of shock, treatment for neurogenic shock is started with fluid resuscitation. Thus fluid resuscitation with maximum of 2 liters of isotonic crystalloids is indicated. Management with excess of crystalloid treatment will lead to acute pulmonary edema especially in elderly people with cardiac failure. Objectives we set in neurogenic shock management is to ensure adequate perfusion seeking the following parameters (4):

- achieve a systolic pressure of 90-100 mmHg and avoiding hypotensive episodes (9,10);
- maintain adequate oxygenation and perfusion of the injured spinal cord - important aspect of treatment, consider oxygen supplementation and mechanical ventilation (9.11).
- heart rate should be within the range 60-100 beats / min in sinus rhythm;
- bradycardia with hemodynamic significance should be treated with atropine;
- urinary flow should be at least 30 ml/h - is required to insert an urinary catheter to monitor urine output and bladder decompression for neurogenic bladder;
- inotropic support may be necessary (dopamine, norepinephrine) - indications: patients with low urine output despite adequate fluid volume resuscitation or presence of hypotension after adequate fluid filling;
- prevent hypothermia.

Spinal shock is defined as complete loss of all neurological function, including reflexes and rectal tone. This physiological status is a transient depression of reflexes of spinal cord function distal to a certain level of lesion. Frequently, the initial phase is seen as increase in BP due to release of catecholamines, then settling down the hypotension. Furthermore is present a flaccid paralysis, including urine and bowel incontinence sometimes associated with priapism. These symptoms may last from hours to days until it starts to refunction the reflex arc.

Neurological assessment

Take careful and documented neurological evaluation, including sensitivity to light touch and painful stimuli ("pinprick" technique), proprioreception, muscular weakness, muscle tone, coordination, tendon reflexes. The presence of a complete motor deficit and/or sensory involves a complete spinal cord lesion; however such a deficit can be partially where an incomplete injury has recovery chances. The accuracy of the initial examination is important as cephalic progression of such damage deficits can mean a progressive deterioration where a special attention must be focused on the cervical region due to the risk of respiratory failure (5).

Do not forget to record the location that has a distal motor and sensory function intact (normal) (5).

Examination of vertebral spine

Examined patient should be handled by a medical team who has a duty to correlate perfectly to keep the spinal axis straight throughout the manipulation. The rescuer positioned at the patient's head will lead the team. Approaching by using the "log roll" technique will allow patient safe turning to one side. The patient is examined by palpation of the entire spine, vertebra by vertebra starting from the cervical area. We have to look for the presence of pain on palpation, deformation, presence of gibbous, widening interspinous spaces or unusual prominence of spinous processes. Remember that in some cases of spine fracture pain may be absent on palpation (5). Keep patient covered and limit heat loss because low sympathetic vasomotor tone has an increased risk of hypothermia.

The process of identification of patients at risk for spinal cord lesion specialized literature presents two evaluation systems based on clinical decisions:

• ***NEXUS study (National Emergency X-radiography Utilization Study)*** based on low risk criteria is a multicenter prospective observational study performed on 34,069 patients in 21 emergency departments across USA. This study (Appendix 1) presents five criteria for the clinical clearance of a possible spinal injury:

- without any midline cervical pain
- without any focal neurological deficit
- conscious and oriented patient
- nnot under the influence of toxic substances
- without any painful injuries that could distract attention from the spinal injury

The sensitivity of this system was estimated at 99.6% and a specificity of 12.9%.

• ***The study "Canadian cervical spine Regulation"*** is a prospective study performed on 8924 patients in 10 emergency departments across Canada. The system developed in this study (Appendix 1) presents with a sensitivity of 100% and a specificity of 42.5%.

Both references proposed steps in the evaluation of the patient with trauma cervical spine are found in ATLS course (3) as follows:

1. Presence of Paraplegia and tetraplegy constitutes evidence and a high degree of suspicion for trauma associated with instability of the vertebral column.

2. Patient conscious, oriented, without neurological signs and painless to palpation of cervical midline. This patient has extremely low probability of having a cervical fracture. Keeping the patient in supine, remove collar and palpate midline of the cervical interspinous region. If this does not cause pain then ask the patient to rotate head 45° left and right. Never, force the patient neck to achieve this movement. It is generally safe when the maneuver is performed voluntarily by the patient. If the patient can perform this maneuver without pain, ask the patient to perform voluntary neck flexion and extension. If the patient makes this movement without any pain then imaging investigations are unnecessary.

3. Patient conscious, oriented, cooperative and without neurological signs, able to focus on assessing

cervical spine showing midline cervical pain on palpation is a real challenge for the clinician. At this time the medical act is loaded by responsibility in excluding spinal injuries. In this case the patient should have imagistic investigations. The handy, inexpensive, quick and simple procedure is performing a series of x-ray with 3 incidence - anterior-posterior, lateral and odontoid incidence with open mouth. If these incidences cannot be made or if the quality of the x-ray is unsatisfactory or if the x-ray has abnormalities then a CT scan of the cervical spine must be performed. X-ray with lateral incidence can be valid only for viewing the whole cervical column distally until T1. If this incidence is not possible then we can choose "swimmer" incidence.

Evaluation films must point out a number of issues required:

- bone deformities
- fractures of vertebral bodies or vertebral processes
- loss of vertebral body alignment
- increased space between the spinous processes
- narrowing of the spinal canal
-increased prevertebral space corresponding soft structures.

If there's no change in the X-ray then cervical collar can be removed. If symptoms persist, consult an expert and request lateral X-ray incidence of the head in flexion and extension for exclusion of subluxation. If radiographs confirm the suspected abnormalities then keep the cervical collar and seek for admission/neurological consultation. In recent years more and more centers consider CT scan as the "gold standard" for spine trauma assessment.

4. Patient with altered level of consciousness or pediatric patient (cannot render objective symptoms) should undergo imaging investigations (3 incidence x-ray or CT). If cervical spine imaging is normal, cervical collar may be removed after appropriate assessment is performed by an experienced physician. Ruling out an injury and removing a cervical collar is important especially when the patient presents with impaired respiratory function. Immobilizing the patient may restrict respiratory compliance or if there's an ongoing resuscitation this make difficult to perform advanced procedures.

5. In case of doubt leave cervical collar and seek advice immediately

TREATMENT

Emergency treatment goals are preventing spinal immobilization alongside avoiding secondary lesions, pain control and limitation of spinal cord compression.

In this chapter we will focus on corticosteroid therapy, which is still controversial topic in the literature. Theoretically, it is known that glucocorticoids would take effect by reducing the effect of the neurotransmitter noradrenaline, stabilizing cell membranes, preventing release of lysosomal enzymes, inhibition of the activity complement system stabilization of sodium and potassium balance resulting from tissue necrosis and edema (7). But in practice the efficiency of steroid treatment produces inconsistent results, especially in aspects during the treatment. These aspects are added and adverse effects cannot be neglected such as increased incidence of infections and risk of avascular necrosis. Following the controversy generated by NASCIS II and III studies, several specialized international societies revised their guidelines for steroid therapy in trauma with spinal injury. Last International Congress of Neurosurgery concluded that steroid therapy "will be chosen in the presence of evidence to suggest that clinical benefits outweigh the side effects". ATLS course refers to corticosteroid therapy in spinal trauma as "a recommended treatment" rather than "the recommended treatment". The Canadian Association of Emergency Medicine Doctors no longer recommends treatment with high-dose methylprednisolone as a standard treatment.

Medscape in one comprehensive material on the subject describes the benefit of steroid treatment as modest, but in patients with complete or incomplete quadriplegia, this can make improvements on motor function of one or more muscles. In the absence of concrete evidence on steroid treatment, Medscape and the latest literature publications recommend treating patients with spinal injury following local protocols, leaving the decision to practitioners. But if the doctor decide for this treatment, it should be initiated within 8 hours after injury according to the following protocol: methylprednisolone 30 mg/kg bolus 15 min. followed by 45 min break after that continuous administration of methylprednisolone 5.4 mg/kg/h for 23 hours.

Bibliography:

[1] Ajani A., Cooper D., Scheinkestel C. *Optimal Assessment of Cervical Spine Trauma in Critically Ill Patients*: A Prospective Evaluation. J Trauma 1998; 26:487-491.

[2] Hoffman JR et al. *Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma*. N Engl J Med 2000; 343:94-99.

[3]Colegiul American al Chirurgilor, Comitetul de Traumatologie – *Advenced Trauma Life Support*, 2008.

[4] Lawrence S Chin, Allen R Wyler www. medscapecom – Spinal Cord Injury, 2012.

[5] Jonathan P. Wyatt ; Robin N. Illingworth ; Colin A. Graham ; Kerstin Hogg – Oxford Handbook of Emergency Medicine, 2012.

[6] J. Marx, R. Hockberger, R. Walls - Rosen's Emergency Medicine, 7th edition, 2009.

[7] J. Hall, G. Schmidt, L.Wood - Principles of Critical Care, Third Edition, 3rd edition, 2005.

[8] Judith Tintinalli şi colaboratorii – *Medicina de urgență*, ediția a șasea, 2008.

[9] Wuermser LA, Ho CH, Chiodo AE, Priebe MM, Kirshblum SC, Scelza WM. Spinal cord injury medicine. 2. Acute care management of traumatic and nontraumatic injury. *Arch Phys Med Rehabil*. Mar 2007;88(3 Suppl 1):S55-61. [Medline]

[10] Congress of Neurologic Surgeons. Blood pressure management after acute spinal cord injury. *Neurosurgery*. Mar 2002;50(3 Suppl):S58-62. [Medline].

[11] Acheson MB, Livingston RR, Richardson ML, Stimac GK. High-resolution CT scanning in the evaluation of cervical spine fractures: comparison with plain film examinations. *AJR Am J Roentgenol*. Jun 1987;148(6):1179-85. [Medline]