

Review article

Practical aspects of acute traumatic spinal cord injury in Orthopedic Surgery and Traumatology: Literature review

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Abstract: Acute traumatic spinal cord injury consists of motor, sensory and/or autonomic involvement of the spinal cord after trauma. It is suspected in cases where a high-energy trauma occurs or where radicular symptoms of a sensory, motor or autonomic type are present. It is the D of the ATLS protocol, and must be assessed once the patient is stabilized. To describe the type of injury, the ASIA scale is used, which classifies them based on whether these injuries are complete or incomplete. These incomplete injuries will then be classified based on whether they preserve sensory, motor or both functions. Surgical treatment will be indicated in those incomplete injuries, and should be emergent (< 6-24h) in those that are evolving, and urgent (< 24-72h) in those that are not evolving.

Keywords: acute spinal cord injury, ASIA scale, ATLS protocol.

1. Introduction

Acute traumatic spinal cord injury consists of motor, sensory and/or autonomic impairment of the spinal cord following a trauma, usually of high energy. This injury generates a serious public health problem due to its high rate of disability, serious complications and medical expenses. ¹

In the United States, the incidence is 54 cases per million inhabitants, representing approximately 17,800 new cases per year. It affects men more than women, who account for 78% of those affected. ² The causes of this type of injury include traffic accidents (36-48%), assaults (5-29%), falls (17-21%) and sports accidents (7-16%). The average age of injury is 31.7 years, with the highest frequency between 15 and 25 years of age. ^{3,4}

It should be especially suspected in any patient with vertebral involvement after high-energy trauma or who presents radicular symptoms of a sensory, motor or autonomic type. The initial mechanism of the trauma includes compression and traction forces, which injure the central and peripheral nervous system secondary to the fracture and displacement of bone and ligament elements. ³

The objective of this study is to show the management of the patient with acute spinal cord injury, explaining the neurological examination using the ASIA scale.

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2. Material and method

Pubmed) and Scopus databases . No linguistic or publication year limits were established.

The search terms were “ spinal cord injury ”, “ management ” and “ acute traumatic ”. The evaluation of the articles was carried out after reading the title, the abstract and the keywords.

3. Results

3.1. Management

Management is guided by the ATLS protocol:

- A, B and C refer to initial priority care, provided by Anesthesiology/Emergency Medicine.
- D is the neurological assessment, at which time the spinal cord injury examination will be performed once the patient is stabilized.

Once the patient has been neurologically examined, it is time to request the corresponding complementary imaging tests:

- X-ray : always necessary.
- CT of the spine : with the aim of classifying fractures, assessing the integrity of the canal and possible associated injuries, and planning a possible surgical intervention.
- MRI of the spine : for the study of ligamentous/discal and associated vascular injuries and to determine, among others, spinal cord involvement. It should be requested urgently in the following cases:
 - Incomplete spinal cord injury.
 - Spinal cord injury not justified by radiographic studies.
 - Progression of neurological damage
 - Cervical fracture-dislocation that cannot be explored before reduction, or in case of reduction failure.

Regarding surgical management, the key points are as follows:

- Any progressive spinal cord injury must be treated surgically on an emergency basis (< 6-24 hours). From a legal point of view, we are particularly interested in this, since failure to intervene in the event of neurological spinal cord damage is considered malpractice .⁵
- An incomplete, non-evolving spinal cord injury must be treated urgently (< 24-72h).
- Complete spinal cord injury does not benefit from urgent surgical intervention.

Once the neurological assessment has been carried out, we must re-examine the patient every 2 hours to determine the progression of the damage (and therefore be a candidate for emergency surgery).

3.2 . Neurological examination – ASIA scale

The neurological assessment is carried out using the ASIA ⁶ scale, which allows:

- Define the level of injury.
- Compare the evolution of the injury.
- Making therapeutic decisions.
- Establish the functional prognosis.

3.2.1. Sensory exploration

The sensitive level is considered the most abundant with preserved sensitivity.

a) Superficial sensitivity

Using the tip of a paper clip or similar, compress the different dermatomes. It is important to compare occasionally with the contralateral dermatome to determine if there is any predominance.

Surface sensitivity grading : ⁷

- **0**: absent.
- **1**: altered (hypo-/hyperesthesia).
- **2**: normal.
- **NE**: not explorable.
- *****: involvement not related to Acute Spinal Cord Injury (for example, a patient who had involvement of the median nerve for any other reason, the corresponding dermatomes will be affected).

The following images indicate the key points where it is recommended to assess superficial sensitivity:

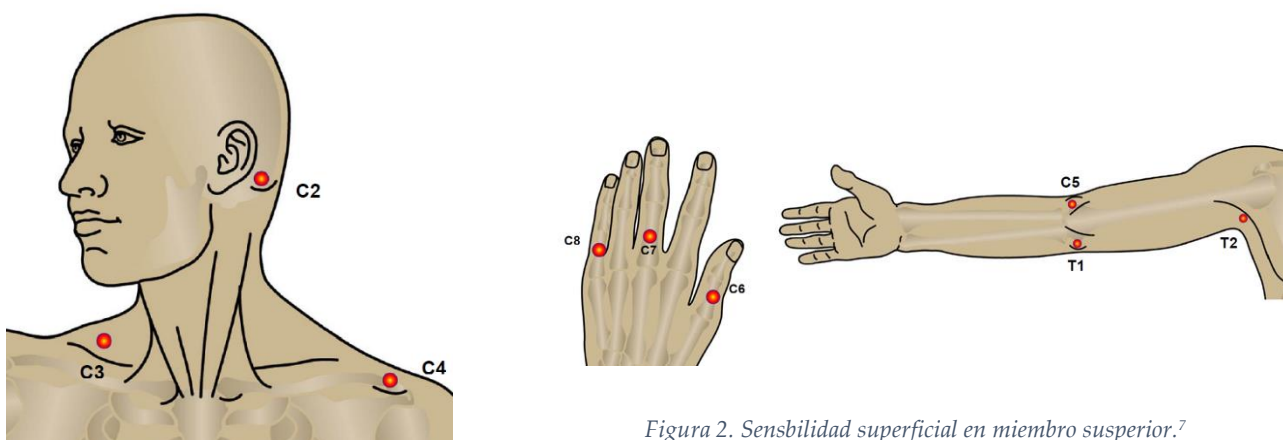


Figure 1. Superficial sensitivity in the neck. ⁷

Figura 2. Sensibilidad superficial en miembro superior.⁷

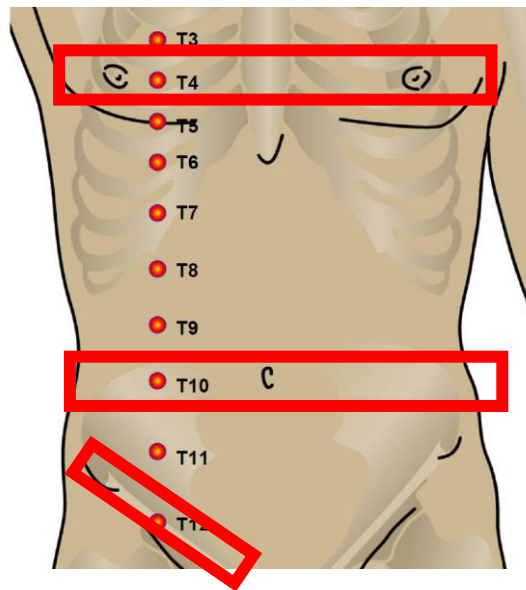


Figure 3. Superficial sensitivity in the trunk.⁷

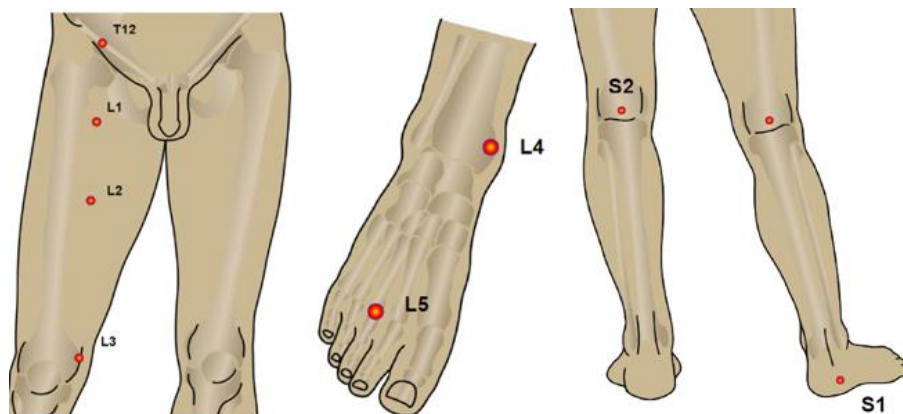


Figura 4. Sensibilidad superficial en miembro inferior.⁷

b) Proprioceptive sensitivity

Without the patient looking, MMSS proprioception is determined by gently taking the 1st finger of the hand and moving it randomly up/down while asking the patient what position it is in.

Similarly, MMII proprioception is determined by performing the same maneuver, but in this case on the 1st toe.

Proprioception grading:⁷

- **Preserved** : always right.
- **Altered** : sometimes fails.
- **Absent** : systematically fails.

c) Deep anal sensitivity

A rectal exam is required and an assessment must be made of whether the patient feels anything.

It is essential to perform a digital rectal examination since an absence of superficial sensitivity in the lower limbs but preserved deep anal sensitivity would also be classified as ASIA-B instead of ASIA-A.

3.2.2. Motor exploration

key muscles is assessed , i.e. the representative muscles of a spinal segment. There are 20 key muscles, with 5 muscle groups, which must be assessed in each limb.

As for the assessment, it is carried out using a scale from 0 to 5: ⁸

- 0 : complete paralysis.
- 1 : visible or palpable contraction.
- 2 : active movement with full range without gravity.
- 3 : Active movement with full range against gravity.
- 4 : Active movement with full range against moderate resistance.
- 5 : Active movement with full range against full resistance.
- NT : not testable (e.g. due to amputation, immobilization due to fracture, etc.).

Below are the different key muscle groups, together with their corresponding examination (on the left, the examination with gravity and on the right, the same in the absence of gravity):

a) Upper limb:

- Elbow flexors (C5) : biceps and brachialis muscles.



Figure 5. C5 root exploration. ⁸

- Wrist extensors (C6) : extensor carpi radialis longus muscle and extensor carpi radialis brevis muscle.

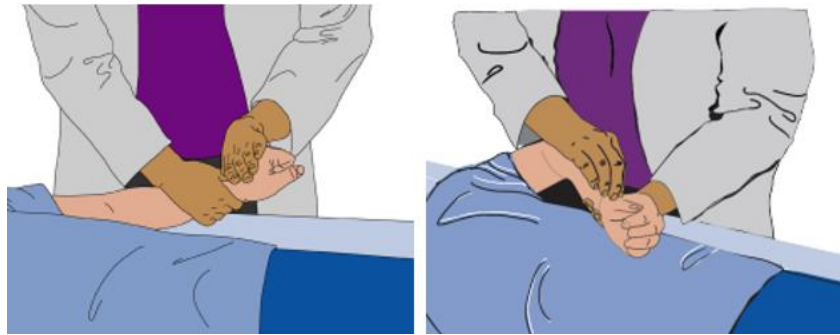


Figure 6. C6 root exploration. ⁸

- Elbow extensors (C7) : triceps muscle.

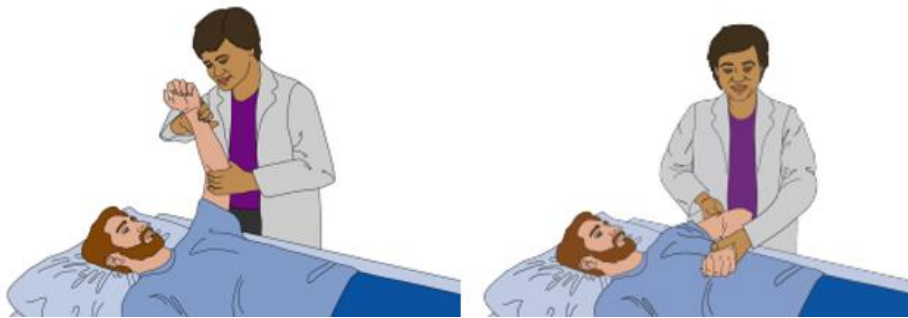


Figure 7. C7 root exploration. ⁸

- Finger flexors (flexing of the distal IP of the third finger is tested) (C8) : deep common flexor muscle of the fingers of the hand.

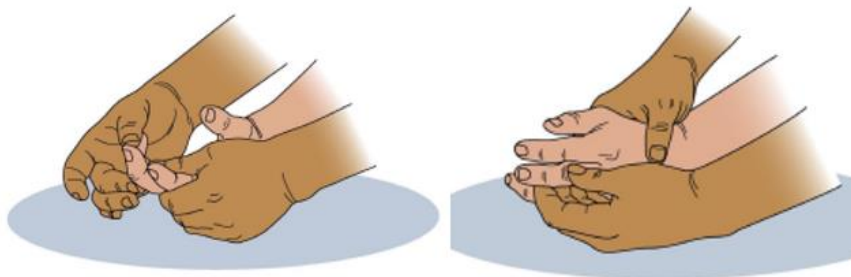


Figure 8. C8 root exploration. ⁸

- Abductor quintus (T1) : abductor muscle of the little finger.

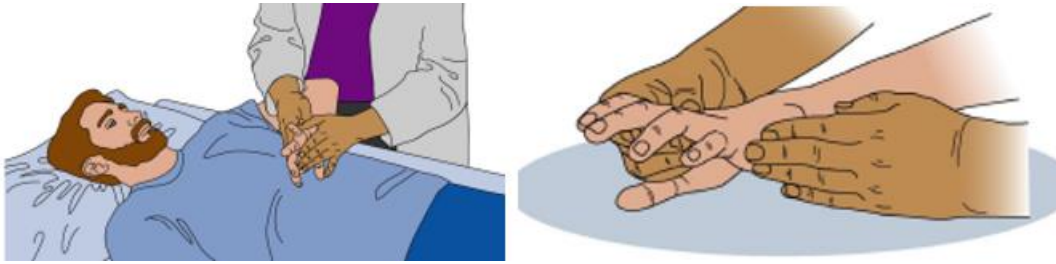


Figure 9. T1 root exploration. ⁸

b) Lower limb:

- Hip flexors (L2) : iliopsoas muscle.

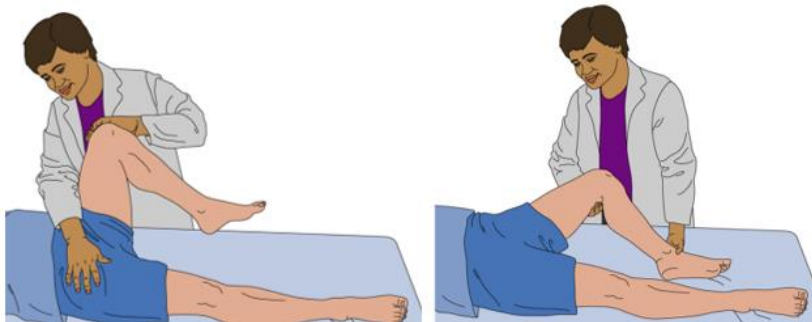


Figure 10. L2 root exploration. ⁸

- Knee extensors (L3) : quadriceps muscle.

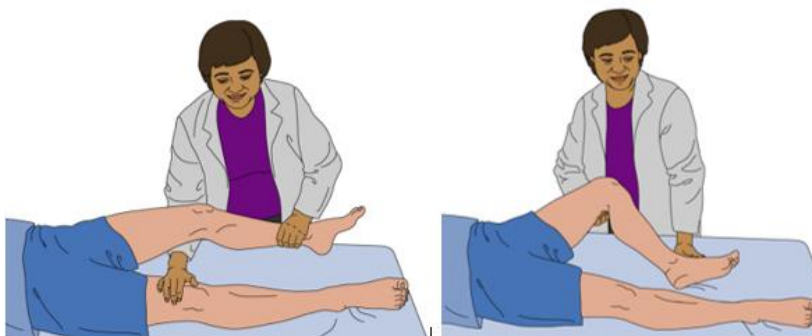


Figure 11. L3 root exploration. ⁸

- Ankle dorsiflexors (L4) : tibialis anterior muscle.

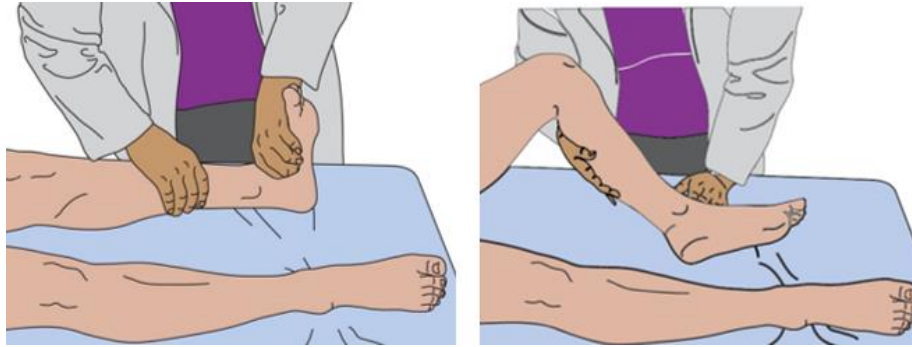


Figure 12. L4 root exploration. ⁸

- Extensors of the first finger (L5) : extensor hallucis longus muscle.

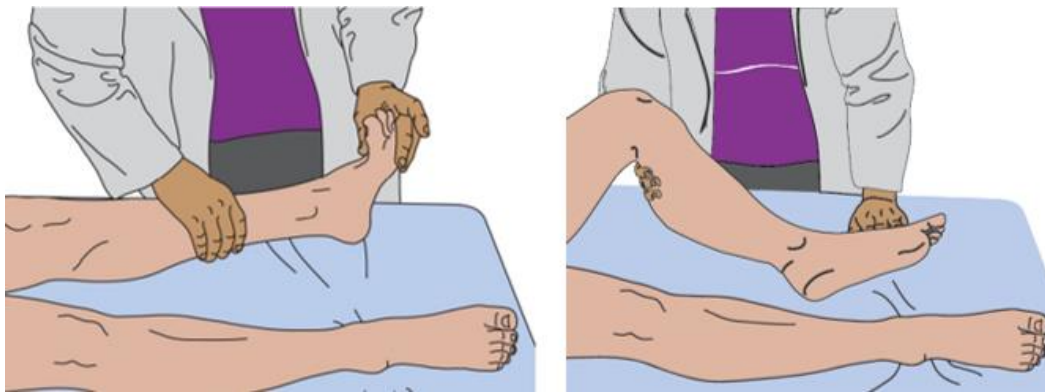


Figure 13. L5 root exploration. ⁸

- Plantar flexors (S1) : gastrocnemius and soleus muscles.



Figure 14. S1 root exploration. ⁸

Voluntary anal contraction should also be assessed by digital rectal examination. It is important to note that if this voluntary anal contraction is positive, even in the absence of any other motor activity below the level of injury, it would be classified as ASIA-C.

3.3. Grades – ASIA Impairment Scale (AIS)

Based on the examination we can stipulate a level of injury and a **degree of affectation** : ⁶

Table 1. ASIA grades.

DEGREE	TO	B	C	D	AND
TYPE OF SPINAL CORD INJURY	Complete	Incomplete sensitive	Incomplete motor		Mild or none
DESCRIPTION OF THE INJURY	Complete motor and sensory system extending to sacral segments S4-S5	Preservation of sensory function below the neurological level of the lesion extending to the sacral segments S4-S5; or preservation of deep anal sensitivity. Absence of motor function.	Preservation of motor function below the level of injury and more than half of the key muscles below the level of injury have a balance less than 3 (1 or 2); or anal sphincter contraction.	Preservation of motor function below the level of injury and more than half of the key muscles below the level of injury have a balance of 3 or more	Normal motor and sensory function

4. Discussion

Advances in neuroscience and the increasing emergence of multidisciplinary teams trained in acute spinal cord injury allow for a better description of the type of injury and, consequently, more appropriate management of it.

Acute spinal cord injuries are usually associated with high-energy trauma such as traffic accidents or falls from a height, but in older people or those with pre-existing spinal diseases, spinal cord injury can occur with minor trauma .

The assessment of spinal cord injury, which is carried out in the neurological examination that constitutes the D of the ATLS protocol, is carried out by applying the ASIA scale. The spinal cord injury is named based on the last healthy

bilateral level, and we have to assign a single level of injury. The traumatic injury will not always have the same level as that of the vertebral fracture. ^{6,10}

The ASIA scale must be applied with the patient in a supine position, exploring sensitivity without the presence of clothing and assessing the myotomes bilaterally and at all levels.

As for imaging tests, these will depend on the circumstances of the trauma, the need to perform tests to diagnose associated injuries and the techniques available at each hospital.

Radiological examination of the entire spine is recommended, since the incidence of multiple vertebral fractures is approximately 20%. CT will more easily and accurately show the presence of fractures, which may be missed on plain radiographs. Magnetic resonance imaging is indicated in patients with neurological deficits that are not explained by radiological findings or when neurological deterioration occurs to rule out the presence of epidural haematoma or another cause requiring urgent surgical treatment. ⁹

As for urgent surgical management, this will not provide any benefit in complete injuries. If the injury is incomplete and not progressing, the intervention will be carried out urgently, in less than 24-72 hours, but if it progresses, it will be carried out urgently, in less than 6-24 hours.

4. Conclusions

Acute spinal cord injury consists of motor, sensory and/or autonomic impairment of the spinal cord. It is class D of the ATLS protocol and must be assessed once the patient is stabilized.

The ASIA scale is used to describe the type of injury, which classifies them based on whether they are complete or incomplete, and the latter based on whether they preserve sensory, motor or both functions. This will be of great relevance for the assessment of the patient's surgical treatment.

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Conflicts of interest: The authors declare that there are no conflicts of interest.

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