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Two cases of Brown-Séquard syndrome in penetrating spinal cord injuries

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Abstract. – INTRODUCTION: Brown-Séquard syndrome due to a stab injuries is uncommon and results from a lesion in one half of the spinal cord.

BACKGROUND: The role of surgery in the treatment of penetrating spinal injury often remain controversial.

AIM: To discuss the current diagnostic and therapeutic approach for these types of injuries.

MATERIALS AND METHODS: The Authors describe two rare cases of Brown-Séquard syndrome due to civilian stab injuries differently treated. Mechanism of damage, clinical features and neurological outcome are reported.

RESULTS: The recovery of neurological function in the first case indicates that the spinal tracts were injured by a contusion, rather than by a direct injury as in the second case. Moreover, surgery was required in the second patient to remove the weapon and to stabilize the spine, presenting bony and ligamentous instability.

DISCUSSION: The diagnostic and therapeutic management are debated. An overview on clinical research in sperimental medical treatment of spinal cord injury was considered to evaluate future possible approaches to these injuries.

CONCLUSIONS: As the neurologic improvement depends on the type and severity of the spinal cord damage, the indications for acute surgical management are limited and conservative management should be preferred.

Key Words:
Brown-Séquard syndrome, Stab injury, Spinal cord injury, Surgical treatment, Biologic therapies, Neurologic outcome.

Introduction

Civilian stab wounds resulting in spinal cord injuries (SCI) are relatively rare and mostly associated with incomplete paraplegia[1].

Brown-Séquard syndrome is the most common neurological pattern due to a transverse hemisection of the spinal cord. The patient presents with ipsilateral loss of motor control, discriminatory/proprioception/vibratory sensation at and below the level involved. On the contralateral side of the body pain and temperature sensation are lost below the lesion[2]. This syndrome in its "pure" form is rare, much more common is the Brown-Séquard "plus" syndrome. In this case the injury may extend to the contralateral side involving the opposite posterior trait of the spinal cord together with its related symptoms consisting of asymmetric paresis with hypalgesia more marked on the less paretic side[3].

Lipschitz[1] assumed three different mechanisms of cord damage by penetrating weapon: 1) direct lesion at the site of impact producing irreversibile neurological deficit 2) impairment of vascular supply resulting in edema with neurological disabilities that usually improves with the decrease of fluid 3) contrecoup spinal contusions or concussions resulting in disabilities may also have a chance to recover.

Neurologic improvement depends on the severity and combination of these three mechanisms.

Background and Aim

The role of surgery in the treatment of penetrating spinal injury has been controversial in literature. Some authors[4,5] have recommended early surgical intervention. On the other hand, Simpson[6] and Klimo[7] demonstrated no significant differences in outcome between surgical and conservative treatments, but an increased risk in the group surgically managed is observed.

We report two cases of Brown-Séquard syndrome after spinal stab injury differently treated, to discuss the current diagnostic and therapeutic approach at our department.

Materials and Methods

Case 1

A 35-years old male sustained a single penetrating injury on his back. The awl was removed by the aggressor himself and was not detected at

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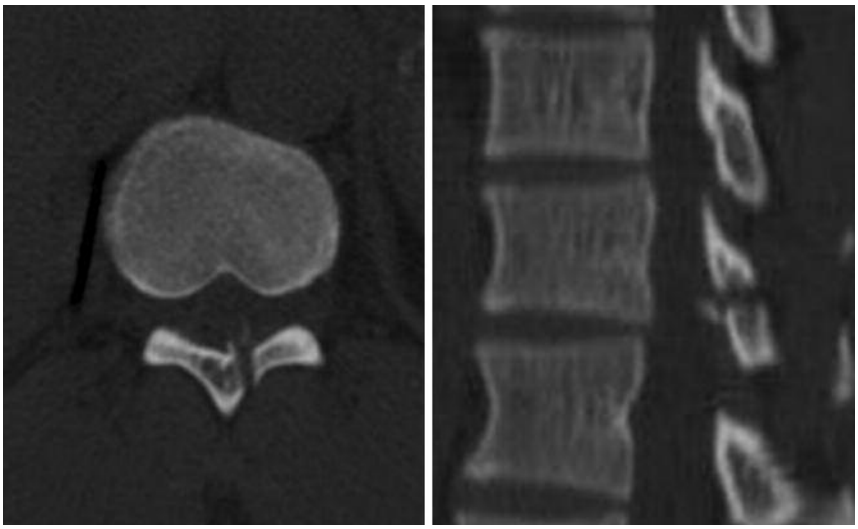

Figure 1. CT scan shows the bone lesion caused by the awl.

the scene of the crime. On arrival to our hospital, the patient was awake and had stable vital signs. Physical examination showed a wound a few millimetres wide at the mid-section of his back medially to the left scapula. Bleedings and leakage of cerebrospinal (CSF) fluid were absent. Neurological examination revealed complete left inferior limb paralisis, complete loss of discriminatory proprioceptive and vibratory sensation below the level of T6 on the left side and a right-sided loss in pain and temperature sensation below T7. Sacral sensation was spared. He was assessed as a grade C by ASIA classification and the findings were diagnostic of Brown-Séquard syndrome. CT scan demonstrated linear fracture in the left lamina of T5 but no foreign body was found (Figure 1). An axial T2-weighted MR image through the level of the lesion showed increased signal intensity in the left side of the spinal cord (Figure 2).

Case 2

A 45-years old female presented to our emergency room with a kitchen knife embedded on the left side of the neck (Figure 3). She had vital signs within normal limits. Bleeding was minimal, with no obvious CSF leakage.

On neurologic examination the patient had left hemiplegia, complete loss of discriminatory proprioceptive and vibratory sensation below the level of C6 on both side and loss of pain and temperature sensation below the level of C8 on

Figure 2. Changes in signal intensity in the left side of the spinal cord are highlighted by the MR.

Figure 3. Radiographic presentation of Case 2.

the right side. Sacral sparing of sensory function was found. SCI was classified as incomplete ASIA C with the features of a Brown-Séquard "plus" syndrome. CT scan revealed intervertebral disc damage and interruption of the posterior column caused by the knife left *in situ*.

Results

Case 1

The patient was managed conservatively with antibiotic profilaxis and clinical observation. No surgery was performed because there were static neurologic deficits, stable fracture and no external object to remove, besides no liquor leakage or intra/extra-dural hematoma were observed.

He was discharged after 5 days. After a 12 month of rehabilitation, the patient neurological status improved in terms of termic/dolorific sensation and motor function with regaining of walking ability (ASIA D). By contrast there is no recovery in proprioceptive and vibratory sensation.

The improvement of motor function and termic/dolorific sensation indicates that the corticospinal and spinothalamic tracts were injured by a contusion, rather than by a direct injury.

Case 2

Surgery was required to remove the weapon and to stabilize the spine presenting bony and ligamentous instability. The knife was removed in the operating theatre under direct visualization to reduce oscillatory movements, dangerous for the neighboring structures: spinal cord and vertebral artery (Figure 4). No laminectomy was performed because there was no visible CSF leakage.

MR, performed only after removal of the metallic object, confirmed the diagnosis showing spinal cord hemisection at the level of C5-C6 on the left side (Figure 5). She did not experience complications and was transferred to a rehabilitation structure after 7 days. Twelve months after surgery the patients had only minor motor and sensory changes (ASIA C). In this case, direct damage of the spinal cord produced an irreversibile neurological deficit. She has been confined to a wheelchair for daily life.

Discussion

According to ATLS standards, if the patient is hemodinamically stable (no arterious bleeding or expansive hematomas) with no damage of aerodigestive organs (trachea and esophagus), we can focus on clinical and imaging studies.

Shortly after arrival in the emergency room, all patients with penetrating injuries should receive tetanus prophylaxis appropriate to their immunization status[8] and antibiotic profilaxis to prevent infection.

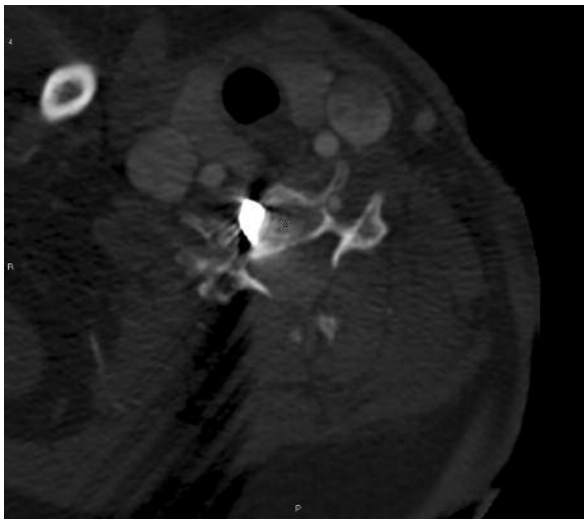

Figure 4. CT scan demonstrates apex of the knife near the right vertebral artery.

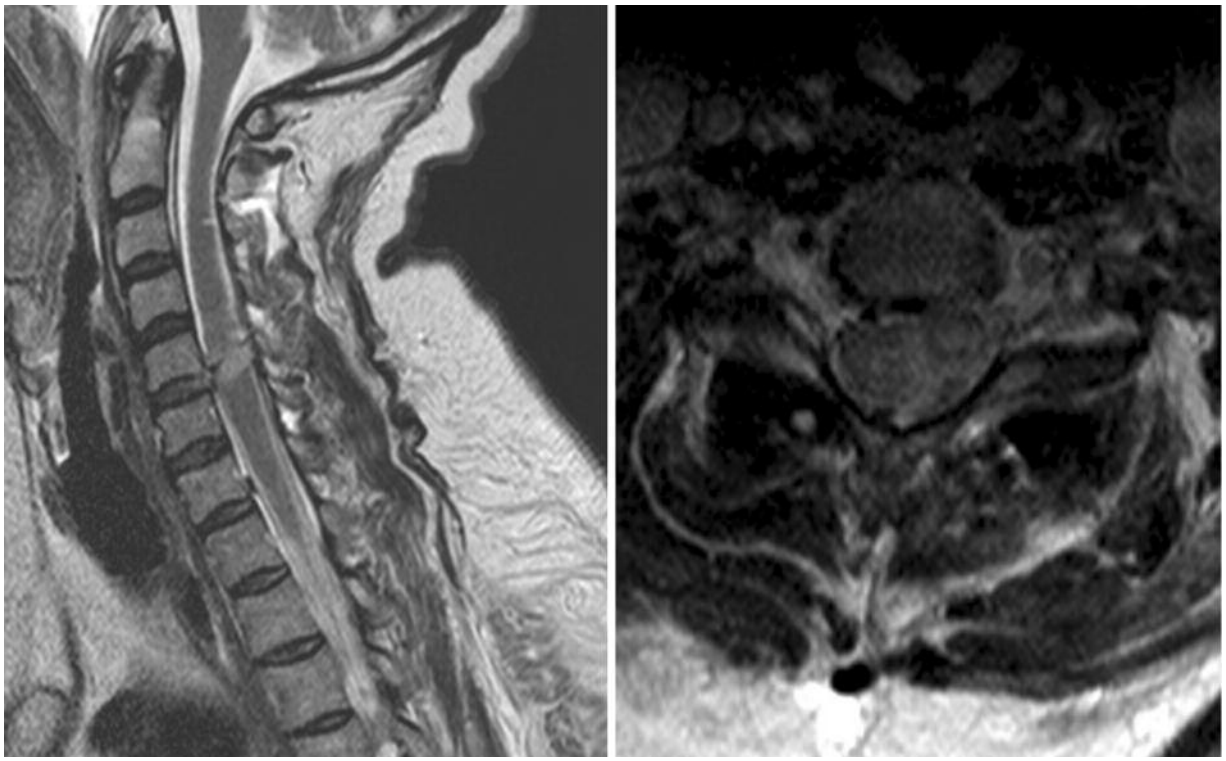

Figure 5. MR showes SCI at the level of C5-C6 on the left side.

We do not use steroid therapy for patients with penetrating spinal cord injuries because it is not recommended[9] and several studies have demonstrated no evidence of neurologic benefit as well as potentially increasing infectious rate[10,11].

During a patient's initial examination, it must be excluded the presence of a CSF leakage from the wound. Sharp objects such as knives that are embedded in the spinal canal should be left in place until their exact relationship to anatomic structures (spinal canal, pleural, and abdominal cavity) is determined[12].

The SCI clinical assessment by the American Spinal Injury Association (ASIA) Impairment Scale[13] can localize the neurologic, sensory and motor levels (through the examination of dermatomes and myotomes), as well as the completeness of a spinal cord injury (based on the detection of sacral sparing).

Brown-Séquard Syndrome is one of the four classic cord syndromes[14] that do not involve S4/S5 sacral segments (incomplete injuries).

The degree of impairment is ranked from A to E following the ASIA score[15].

Standard X-rays demonstrate major bony injuries and the presence of foreign bodies.

In such emergency settings, CT scan with contrast is the best investigating modality to display bony anatomy and stability to plan surgery. It is also important to determine the trajectory/position of foreign bodies, and their relationship with spinal cord and vessels to schedule if more imaging studies are needed.

MR gives us information about edema and anatomical interruption of the spinal cord. The MR, is indicated only after removal of the metallic bodies, because hardware movement and heating due to the magnetic field may worsen the neurological status and produced artifacts that may hamper the correct interpretation of the image for evaluation of spinal cord damage.

Since it is not yet possible to repair a spinal cord interruption, we know that complete neurological restoration is not an aim.

Indications for surgery in penetrating spinal cord injuries include: progressive neurologic deterioration in patient with an incomplete injury of the spinal cord[16], attributable to compression by foreign bodies, bone, or hematoma; external penetrating object retained; CSF leakage; spinal instability.

In patients with neurologic deficits unchanged from the time of injury, there is no evidence that surgical decompression results in clinical improvement, indeed surgery has a worse outcome than non-operative management[17,18].

The neurologic recovery in the first case indicates that the improvement depends on the injury mechanisms regardless of surgery.

The removal of an external penetrating object is universally considered as mandatory, both to prevent infections and further damage to anatomical structures. The embedded object should be removed in the operating room, such as in the second case reported, to prevent further neurologic or vascular damage, and to be ready in case dural repair or spine stabilization is required[19].

If there is no CSF leakage, exploration should not be attempted because of laminectomy itself increases the risk of dural damage. On the contrary, if CSF fistula is present, repair of dural tears is mandatory to prevent late complications such as infection or meningitis.

Stabilization is to be considered when spinal instability occurs to prevent further damage on the spinal cord.

Spinal cord injuries are a relevant issue since they are increasing in prevalence and incidence[20]. Medical research is evaluating pharmacological approaches which seem to be effective in preclinical trials[20-23].

The initial trauma, or primary injury, starts a sequence of pathological pathways which can be referred to as second injury: hypoxia (caused by vascular damage) is the trigger which leads to ionic imbalance, peroxidation of cellular membranes, free radicals formation and release of toxic levels of Glutamate excitatory neurotrasmitter. Clinical research is focusing on neuroprotective agents to mitigate secondary injury mechanisms. On the other hand, researchers are also studying the regenerative capacity of the central nervous system to repair neuronal damage rather then reducing it[22,23].

Neuroprotective agents have been studied, methylprednisolone (as reported before) is not used anymore because of its limited evidence in efficacy and because of the increase of risk of complications (infections, wound problems). Riluzolo is a sodium channel blocker which in preclinical models reduces neuron degeneration by reducing the release of Glutamate. Minocycline, has shown to be neuroprotective in animal injury models, its exact mechanism of action is still not understood, but since it's already used in other clinical conditions in humans (such as acne), its use would be safe. Basic Fibroblastic Growth Factor has been shown to be effective in animal injury models by reducing Glutamate-mediated excitotoxicity.

Neuroregenerative agents represent a promising approach[23]. Anti-Nogo is a monoclonal antibody which blocks Nogo A protein (which blocks axonal growth in the human central nervous system)[21-23]. Cethrin, a bacterial-derived toxin that inhibits the Rho pathways of inhibitory proteins and promotes axonal growth in vitro.

Transplantation of stem cells should be finally considered because, even if far from being clinically used, preclinical studies showed that it enhanced neuro-behavioural recovery[20].

What we can actually do in our daily clinical experience is limited to the Knowledge we have concerning secondary injury mechanisms. In an intensive care unit hemodynamic support to maintain perfusion optimal and therapeutic hypothermia to reduce the metabolism and therefore the production oxidative damage is theoretically possible, but still not standardised[20].

Conclusions

Neurologic improvement of Brown-Sèquard syndrome after penetrating spinal injuries depends on the severity and combination of three different mechanisms: direct damage, vascular accident or contusion.

Since surgical repair of spinal cord is not yet achievable, the neurologic prognosis does not depend on surgery, but on the recovery from a neurological stupor which occurs when edema and temporary ischemia are worked out.

Appropriate medical and surgical management are important to prevent further damage of the neurological status and complications, to remove external penetrating objects, to stabilize fractures, to evacuate intra/extra-dural hematoma and to repair a CSF leakage waiting for a possible neurological recovery.

Indications for surgery must be respected and if possible, conservative management should be preferred over the aggressive surgical approach to avoid iatrogenic complication.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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