Brown-Sequard syndrome associated with a spinal cord injury caused by a retained screwdriver: A case report and literature review

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ABSTRACT

Background: Nonmissile penetrating spine injury (NMPSI) represents a small percent of spinal cord injuries (SCIs), estimated at 0.8% in Western countries. Regarding the causes, an NMPSI injury caused by a screwdriver is rare. This study reports a case of a retained double-headed screwdriver in a 37-year-old man who sustained a stab injury to the back of the neck, leaving the patient with a C4 Brown-Sequard syndrome (BSS). We discuss the intricacies of the surgical management of such cases with a literature review.

Methods: PubMed database was searched by the following combined formula of medical subjects headings, (MESH) terms, and keywords: ((SCIs [MeSH Terms]) OR (nmpsi [Other Term]) OR (nonmissile penetrating spinal injury [Other Term]) OR (nonmissile penetrating spinal injury [Other Term])) AND (BSS [MeSH Terms]) OR (BSS [MeSH Terms]).

Results: A total of 338 results were found; 258 were case reports. After excluding nonrelated cases, 16 cases were found of BSS induced by spinal cord injury by a retained object. The male-to-female ratio in these cases is 11:5, and ages ranged from 11 to 72. The causes of spinal cord injury included screwdrivers in three cases, knives in five cases, and glass in three cases. The extracted data were analyzed.

Conclusion: Screwdriver stabs causing cervical SCIs are extremely rare. This is the first case from Iraq where the assault device is retained in situ at the time of presentation. Such cases should be managed immediately to carefully withdraw the object under direct vision and prevent further neurological deterioration.

Keywords: Brown-Sequard syndrome, Retained foreign body, Screwdriver, Spinal cord injury

INTRODUCTION

Nonmissile penetrating spine injury (NMPSI) represents a very small percent of spinal cord injuries (SCI), estimated at 0.8% in Western countries, but can go up to 26% in countries like South Africa where the rates of street violence are high.[27,32] These injuries mainly affect the lower cervical and upper thoracic region.[40] An NMPSI injury caused by a screwdriver is rare.[31] Two
large South African studies involving cohorts of 130 and 450 individuals with spine stab wounds provide the most evidence for this entity.\cite{22,28} There are rare case reports and small series in the literature.\cite{4,12,29,35} Brown-Sequard syndrome (BSS) is a pattern of incomplete SCI where hemisection of the spinal cord manifests as ipsilateral paresis and loss of vibration and proprioception at the level of injury, with contralateral loss of pain and temperature sensation 2–3 levels below the injury.\cite{1,25} It represents about 17% of incomplete cord injuries.\cite{24}

Patients with traumatic BSS generally have the best outcomes of any type of SCI, and 75–90% of those patients ambulate within 1 month of inpatient rehabilitation.\cite{24,30}

The authors report a case of a retained double-headed screwdriver in a 37-year-old man who sustained a stab injury to the back of the neck, leaving the patient with a C4 BSS. We discuss the intricacies of the surgical management of such cases with a literature review of the related cases.

**CASE PRESENTATION**

A 37-year-old male presented to the emergency department after an assault and injury to the back of the neck with a double-headed screwdriver while the patient was leaning forward [Figure 1]. The screwdriver inlet was a few centimeters left to the midline area at the level of C4 vertebra. The injury was caused by the flathead while the star head remained outside.

On examination, the patient was alert with a GCS of 15, laying in a prone position; the screwdriver was impacted in the back of the neck and hardly fixed, with minor bleeding around the inlet. The patient had right-sided hemiplegia (upper and lower limbs), Medical Research Council Grade 0/5 with loss of vibration and proprioception on the same side, and loss of pain and temperature sensation on the contralateral side of the body (Brown-Sequard injury), and urinary retention, which necessitated the insertion of a Foley catheter.

Cervical computed tomography (CT) scan showed the screwdriver going through the right lamina of C4 and entering the dura and the spinal cord, the tip reaching just medial to the transverse foramen of C4 [Figure 2].

The patient was taken to the operating room immediately. Under general anesthesia (tube in a lateral position), surgical exploration was performed by a midline skin incision from C1 to C7 with dissection of the fascia and muscle to reach the screwdriver entrance. C4–C5 laminectomy was performed, the ligamentum flavum was removed [Figure 3a], and the midline dural damage was discovered and surgically expanded. The screwdriver was progressively withdrawn parallel to the entrance tract under direct vision, and right hemi-cord damage was noticed [Figure 3b]. Surgicel® was used to manage minor bleeders, the canal was cleaned, and hair and debris were removed, the dura was closed watertight followed by multilayer skin closure.

**Figure 1:** Stabbing in the back of the neck with the screwdriver, with the point of entry just left of the midline.

**Figure 2:** (a) Sagittal computed tomography (CT) of the cervical spine indicates the position of the tip of the screwdriver at the level of C4. (b) Axial CT of cervical spine scan demonstrating the screwdriver going through the right lamina and entering the dura and the spinal cord, the tip reaching just medial to the lateral mass and transverse foramen.

**Figure 3:** (a) Laminectomy of C4-C5 was done, ligamentum flavum was removed, and dural injury was seen in the midline. (b) Following the removal of the screwdriver, damaged tissue of the cord can be seen at the site of injury.
Postoperatively, motor function on the right side of the body improved (upper limb Grade 2 and lower limb Grade 3). Seven days later, the right-sided weakness improved to Grade 3 in the upper limb and Grade 4 in the lower limb, and the urine catheter was removed as the patient regained urinary continence. However, there was no improvement in sensation. The postoperative cervical spine magnetic resonance imaging (MRI) revealed a mixed-intensity lesion in the posterior aspect of the spinal cord at the level of injury, suggesting a spinal cord contusion [Figure 4]. The patient was discharged home. Follow-up and physiotherapy were arranged.

LITERATURE REVIEW

Methods

We conducted a PubMed database search by the following combined formula of medical subject headings, [MESH] terms, and keywords: (((SCIs [MeSH Terms]) OR (nmpsi [Other Term]) OR (nonmissile penetrating spinal injury [Other Term]) OR (nonmissile penetrating spinal injury [Other Term])) AND (BSS [MeSH Terms])) OR (BSS [MeSH Terms]).

RESULTS

A total of 338 results were found; 258 were case reports. By excluding cases of nonretained objects causing spinal cord injury at the time of presentation, and the cases with noninjury induced BSS, we have found 16 reported cases of BSS induced by spinal cord injury by a retained object.

The male-to-female ratio in these cases is 11:5, and ages ranged from 11 to 72. The causes of spinal cord injury included screwdrivers in three cases, knives in five cases, and glass in three cases. Other objects included; sunglasses, dart, iron fence, and Kirschner wire. Thirteen of the reported cases were managed by an operative procedure to decompress the spinal cord and retrieve the causative objects, and two of the cases were conservatively treated.

Improvement was observed during the follow-up period in 12 of the reported cases, while three of the cases reported no improvement in motor and sensory functions or deterioration postoperatively [Table 1].

DISCUSSION

In 1977, Peacock et al. reported a total of 450 spinal cord stab injuries, a publication that remains the major study on the subject thus far. About 26% of all spine assaults they managed over 13 years were attributed to stab injuries. Knives were most frequently used (84.2%), followed by axes, screwdrivers, bicycle spokes, scissors, garden forks, sickles, and sharpened broomsticks. Other reported culprits of NMPSI include: pencils and splinters. Instead of cutting, knives are typically withdrawn after the assault and seldom lodge into bones. Hence, knives are rarely documented as a retained foreign body, while screwdrivers are well established.

When the penetrating object is left in place, as in the present case, certain aspects of managing such injuries become quite
Table 1: The reported cases of retained spinal cord injury causing BSS, according to the injury site, management, and outcome.

| Author/year          | Age/Gender | Stage of BSS/manifestations | Injury site | Injury cause | Management                          | Symptom outcome                                                                 |
|----------------------|------------|-----------------------------|-------------|--------------|-------------------------------------|----------------------------------------------------------------------------------|
| Singh et al., 1995   | 45/M*      | Impaired motor function, muscle tone, sensation, and reflexes on the left side | T1          | Knife        | Surgical intervention with retrieval of the knife | Improvement of the motor function, with analgesia and impaired joint position     |
| Loncán et al., 1998  | 22/M       | BSS***                      | T2-T3       | Kirschner wire Knife | Surgical intervention              | Improvement                                                                      |
| Blackburn et al., 2002 | 27/M      | BSS                         | -           | Knife        | -                                   | -                                                                               |
| Gray et al., 2003    | 30/M       | BSS at the level of C2 along with a visual field defect due to injury of the optic nerves | C1-C2       | Sunglasses temple (arm) | Surgical intervention for the retrieval of the temple | Improvement of vision with persistence of motor function defect. Slight improvement of motor function with physical therapy. Improvement in the motor function with persistence of sensory deficit |
| Jones et al., 2005   | 17/F**     | BSS, 1/5 motor function in the right lower limb, with a sensory deficit on the left side | C3-C4       | Dart         | Surgical intervention for the retrieval of the dart | Surgical intervention                                                          |
| Ye et al., 2010      | 54/M       | BSS                         | T5          | Iron fence   | Surgical intervention               |                                                                                  |
| Giner Pascual et al., 2011 | 35/F | BSS at C5 on the right side | C7          | Knife        | Surgical intervention for the retrieval of the knife | Improvement of the motor function, with analgesia and impaired joint position     |
| Rabiu et al., 2011   | 52/M       | BSS                         | C4-C5       | Screwdriver  | Lamincotomy surgical intervention to remove the blade | No improvement in the motor function with physical therapy. No improvement        |
| Ceruti and Previsdomini, 2012 | 72/F | Asymptomatic, she was alert, quiet, and calm and clinical examination revealed neither cardiorespiratory nor neurological deficit | T1          | Knife        | Surgical intervention               | Slight improvement in the motor function, no improvement.                      |
| Komarowska et al., 2013 | 11/F | BSS                         | T11-T12     | Glass        | Surgical approach                   | Slight improvement in the motor function, no improvement.                      |
| Beer-Furlan et al., 2014 | 34/M | BSS with Grade 4 motor deficit in the left leg | T5-T6       | Screwdriver  | Surgical intervention               | Improvement in the motor function, no improvement.                           |
| Amendola et al., 2014 | 35/M | BSS                         | T5          | Glass        | Conservative                        | Improvement in the motor function, no improvement.                           |
| Amendola et al., 2014 | 45/F | BSS                         | C5-C6       | Knife        | Surgery intervention to retrieve the knife | No improvement in the motor function, no improvement.                          |
| Meena et al., 2016   | 20/M       | BSS                         | T12         | Screwdriver  | Surgical intervention for the retrieval of the screwdriver | Improvement in the motor function.                                          |
| Jesmanas et al., 2018 | 50/M | Weakness and sensory loss in the lower limb | C6-C7       | Glass chip   | Conservative treatment due to the risks of surgery | Slight improvement in the motor function.                                    |
| Rodriguez-Quintero et al., 2020 | 38/M | BSS | Back (unspecified) | Screwdriver | Surgical intervention | Improvement |}

*M: Male, **F: Female, ***BSS: Brown-Sequard syndrome

challenging, such as patient transfer and positioning. Avoiding withdrawal or the slightest movement of retained objects before obtaining imaging and consultation is necessary. A complete neurological assessment must be done immediately to monitor any further neurological damage caused by patient handling, hemorrhage, or infection. Secondary injuries, including vascular injuries, must be ruled out, mainly following stabs to the cervical and dorsal spine. [38]
The imaging modality of choice in NMPSI is a CT scan, which has a high sensitivity for foreign bodies, spinal hematomas, and bony fractures. In emergency settings, a CT scan is also preferred due to its short acquisition time. MRI is not recommended in the case of retained metallic objects, as it can worsen the deficits, incite movement of the metallic foreign body, and even heat it, causing thermal injury to the spinal cord and surrounding structures. Vascular imaging, such as CT or conventional angiography, should be considered when the injury is in proximity to the vertebral vessels or the aorta, as was the case in our patient. However, no vascular imaging modalities were available at the time of presentation.

Operative management is somewhat controversial when it comes to NMPSI. Surgical exploration must be attempted in incomplete neurological deficits, spinal instability, retained foreign body, persistent leakage of cerebrospinal fluid (CSF), CSF fistula, and persistent pain. In cases of retained objects, immediate exploration is advised to avoid any infections and neurological deterioration. Retained materials must be removed in a theater equipped for dural repair or spine stabilization. In the absence of CSF leakage, exploration of the spinal canal should not be attempted, as laminectomy carries a high risk of dural injury. Care should be taken throughout the procedures to avoid manipulating the retained object and causing further neurological damage. Slow, careful removal of the screwdriver should be achieved in a straight line parallel to the entry trajectory, avoiding any sideways manipulation that can worsen the arc of injury to the spinal cord.

In our case, the operation decision was straightforward, as the screwdriver was retained. Surgical exploration was challenging to remove the object safely under direct vision without altering the neurological status and to prevent any possible secondary damage. The complications may include bleeding from epidural venous plexus, spinal traction injury, and CSF leakage.

According to Meena et al., the literature only documents five cases of BSS in the setting of retained foreign material in penetrating SCIs, with their case being the sixth reported up to the time of its publication. Three of the cases were due to screwdriver injury, and only one case involved the cervical spine. All cases were managed immediately, and surgical exploration to remove the retained object was the established practice. Other reported cases of Brown-Sequard due to penetrating injury were managed similarly. Late complications following incomplete spinal cord injury due to retained foreign objects may occur, including intramedullary abscess, myelopathy, progressive neurological deterioration, and symptomatic pseudomeningocele.

In penetrating spinal injuries resulting in BSS, the prognosis relies on the severity, extent of damage to the spinal cord, and whether it has an associated secondary (i.e., vascular) injury. Generally speaking, BSS carries the most favorable prognosis among all SCI syndromes. The prognosis following penetrating trauma is less favorable than that following blunt trauma. However, regardless of the etiology of BSS, marked improvement in motor and bladder control functions can be expected within a few days, which slows down but continues over a period of up to 2 years. About 75–90% of patients are ambulatory within 1 month of rehabilitation, mainly when the initial weakness is upper limb predominant. In summary, this is the first case from Iraq where the assault device is retained in situ at the presentation time. Neurological deterioration can be prevented by managing such cases immediately by carefully withdrawing the object under direct vision.

**CONCLUSION**

Cervical SCIs caused by screwdriver stabs are extremely rare occurrences. We report the first such case from Iraq, where the assault device is retained in situ at the time of presentation. Such cases must be operated on immediately to carefully withdraw the object under direct vision and prevent further neurological deterioration and catastrophic outcomes.

**Declaration of patient consent**

Patient’s consent not required as patient’s identity is not disclosed or compromised.

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**Conflicts of interest**

There are no conflicts of interest.

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