



Review Article

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

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large South African studies involving cohorts of 130 and 450 individuals with spine stab wounds provide the most evidence for this entity.^[22,28] There are rare case reports and small series in the literature.^[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.^[1,25] It represents about 17% of incomplete cord injuries.^[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.^[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.

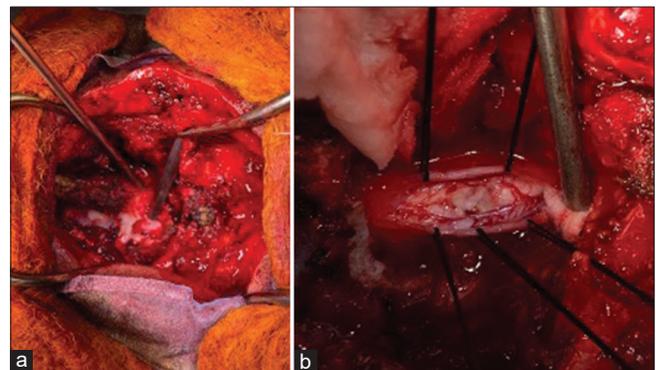


Figure 3: (a) Laminectomy of C4–C5 was done, ligamentum flavum was removed, and dural injury was seen in the midline. (b) Following the removal of the screwdriver, damaged tissue of the cord can be seen at the site of injury.

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.



Figure 4: Postoperative sagittal T1-weighted magnetic resonance imaging shows a mixed-intensity lesion in the posterior aspect of the cord at the level of C4, suggesting spinal cord contusion.

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].^[5,8,13,14,16,23,29,33,36]

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.^[28] 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.^[26,38]

These stabbing injuries mainly occur in the thoracic spine (61%) and least in the lumbar spine (7%).^[4] More than half of these lesions are associated with BSS, a rare neurological condition resulting from spinal cord hemisection. This is manifested as ipsilateral spastic paralysis and loss of proprioception and touch sensation, with contralateral loss of pain and temperature sensation.^[31] BSS commonly arises in cases involving the thoracic spine (75%) followed by the cervical (17%) and lumbar spine (8%).^[6]

Screwdriver impaling in the context of NMPSI is particularly dangerous due to the concentrated force applied to a small area and the forceful stem penetrating the bone deeply. In contrast, stabs with knives tend to deflect and slide sideways by the effect of multiple muscle layers and bony spinal column or snap without penetrating the spinal canal.^[4] In addition, the elongated cross-section of knives makes them more likely to be stopped by the bony posterior arch of the spinal cord unless the stabbing occurs horizontally.^[34] Peacock *et al.* postulated that the defense mechanism introduced by the bony spinous processes and muscular layers could be overcome by the screwdriver, as it is improbable to deflect.^[28] Instead of cutting, it tends to dissect the injured structures, which minimizes tissue damage, a possible explanation for our patient's partial injury and neurological improvement postoperatively.^[2] Unlike screwdrivers, 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.^[7,10,18]

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 <i>et al.</i> , 1995 ^[36]	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 <i>et al.</i> , 1998 ^[23]	22/M	BSS***	T2-T3	Kirschner wire	Surgical intervention	Improvement
Blackburn <i>et al.</i> , 2002 ^[5]	27/M	BSS	-	Knife	-	-
Gray <i>et al.</i> , 2003 ^[13]	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.
Jones <i>et al.</i> , 2005 ^[16]	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	Slight improvement of motor function with physical therapy.
Ye <i>et al.</i> , 2010 ^[43]	54/M	BSS	T5	Iron fence	Surgical intervention	Improvement in the motor function with persistence of sensory deficit
Giner Pascual <i>et al.</i> , 2011 ^[11]	35/F	BSS at C5 on the right side	C7	Knife	Surgical intervention for the retrieval of the knife.	Slight improvement of motor function with physical therapy.
Rabiu <i>et al.</i> , 2011 ^[31]	52/M	BSS	C4-C5	Screwdriver	Laminectomy	No improvement
Ceruti and Previsdomini, 2012 ^[8]	72/F	Asymptomatic, she was alert, quiet, and calm and clinical examination revealed neither cardiorespiratory nor neurological deficit	T1	Knife	Surgical intervention to remove the blade	No improvement
Komarowska <i>et al.</i> , 2013 ^[20]	11/F	BSS	T11-T12	Glass	Surgical approach	Slight improvement
Beer-Furlan <i>et al.</i> , 2014 ^[2]	34/M	BSS with Grade 4 motor deficit in the left leg	T5-T6	Screwdriver	Surgical intervention	Improvement in the motor function
Amendola <i>et al.</i> , 2014. ^[1]	35/M	BSS	T5	Glass	Conservative	Improvement in sensation and motor function, no improvement.
Amendola <i>et al.</i> , 2014 ^[1]	45/F	BSS	C5-C6	Knife	Surgery intervention to retrieve the knife	No improvement
Meena <i>et al.</i> , 2016 ^[25]	20/M	BSS	T12	Screwdriver	Surgical intervention for the retrieval of the screwdriver	Improvement
Jesmanas <i>et al.</i> , 2018 ^[44]	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 motor function.
Rodríguez-Quintero <i>et al.</i> , 2020 ^[33]	38/M	BSS	Back (unspecified)	-	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.^[31] 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.^[40] 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.^[35] 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.^[1] Care should be taken throughout the procedures to avoid manipulating the retained object and causing further neurological damage.^[40] 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.^[3]

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.^[25] 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.^[2,17,19,31,37,43] Other reported cases of Brown-Sequard due to penetrating injury were managed similarly.^[1,11,20,30,39,41]

Late complications following incomplete spinal cord injury due to retained foreign objects may occur, including intramedullary abscess, myelopathy, progressive neurological deterioration, and symptomatic pseudomeningocele.^[9,15,21,42]

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.^[1] 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.^[24] 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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