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Case Report

Recovery of volitional movement with epidural stimulation after "complete" spinal cord injury due to gunshot: A case report and literature review

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ABSTRACT

Background: Epidural spinal cord stimulation (eSCS) restores volitional movement and improves autonomic function after nonpenetrating and traumatic spinal cord injury (SCI). There is limited evidence of its utility for penetrating SCI (pSCI).

Case Description: A 25-year-old male sustained a gunshot wound (GSW) resulting in T6 motor/sensory paraplegia and complete loss of bowel and bladder function. Following eSCS placement, he regained partial volitional movement and has independent bowel movements 40% of the time.

Conclusion: A 25-year-old pSCI patient who, following a GSW resulting in T6-level paraplegia, sustained marked recovery of volitional movement and autonomic function following eSCS placement.

Keywords: Epidural spinal cord stimulation, Gunshot wound, Paralysis, Spinal cord injury, Traumatic injury

INTRODUCTION

Penetrating spinal cord injuries (pSCIs), most often from gunshot wounds (GSWs), comprise one-fifth of all spinal cord injuries (SCIs).[2,7] Although epidural spinal cord stimulation (eSCS) has restored volitional movement and autonomic function in patients with nonpSCIs, there is limited literature regarding its efficacy for pSCI. Here, we demonstrate restoration of volitional movement and autonomic function with eSCS in a paraplegic patient secondary to a T6-level GSW.

CASE DESCRIPTION

History and treatment

A 25-year-old male sustained a GSW to the T6 spine (4/2017); the bullet entered his right shoulder, passed through his lung, and ended up in the T6 vertebrae resulting in paraplegia [Figure 1]. He underwent pneumonectomy, but remained with full motor/sensory paraplegia below the T6 level (i.e., complete motor loss, absent temperature/pain sensation, minimal proprioception, and complete loss of anal and bladder sphincter control). Five years later, he wished to undergo eSCS, but due to the retained missile, he was deemed a poor candidate. Therefore, he first underwent

Figure 1: Sagittal view of thoracic spine preoperative computed tomography. Red arrow indicates bullet location.

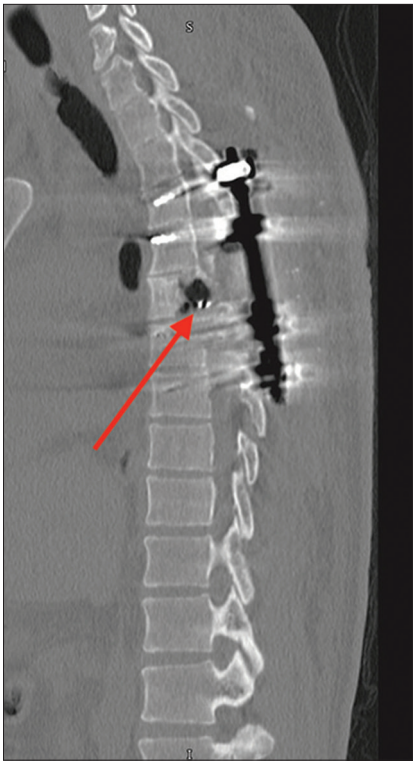

Figure 2: Sagittal view of thoracic spine postoperative computed tomography. Red arrow indicates preoperative bullet location.

a T5-T7 laminectomy for removal of the retained bullet fragment accompanied by the left-sided facetectomies at T5-T6 and T6-T7, and performance of a T4-T8 pedicle/screw fusion. The bullet, lodged extradurally, was removed along with 40% of the T6 vertebral body [Figure 2]. One month later, an eSCS was placed dorsal to the L1-2 vertebral bodies using intraoperative neuromonitoring (i.e., for stimulation of all muscle groups from the iliopsoas to the anterior tibialis, including the anal sphincter) [Figure 3].

Postoperative course and recovery

Two days postoperatively, with eSCS turned on, the patient could perform seated knee extension and hip flexion and began physical therapy and walking therapy [Table 1, Videos 1 and 2]. Burst settings of 30 son and 90 s off were utilized for the full awake day 3–4 times/week; these reduced leg spasms and other non-volitional leg movements. Bladder function did not improve, but 40% of the time, he could independently empty his bowels. Further, back pain and other symptoms consistent with complex regional pain syndrome (Type 2) were eliminated.

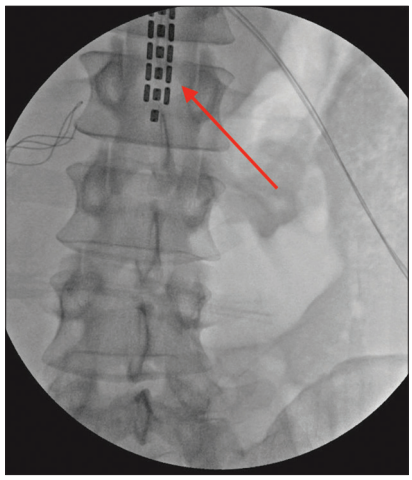

Figure 3: Intraoperative X-ray following epidural spinal cord stimulation placement. Red arrow indicates electrode grid.

DISCUSSION

Although 80% of patients with blunt spinal cord injuries undergo surgery, only 17% of patients with pSCI have surgery.[1,7] Meta-analyses indicate no difference in recovery between operatively versus conservatively-managed pSCI patients; few in either group show meaningful recovery.[2,4,5,8] eSCS improves autonomic function and restores volitional movement in some SCI patients.[3,5,7] We report a 25-year-old pSCI patient who, following a GSW resulting in paraplegia, sustained marked recovery of function following eSCS

Table 1: Stimulation parameters.

Action	# Option	Electrodes	Frequency (Hz)	Pulse width (μs)
Sitting to standing Prolonged standing Transfer from wheelchair to table chair	Option #1		16	210
Step training	Option #1		20	210
Core exercises	Option #1		14	270
Core exercises	Option #2		14	270
Core exercises	Option #3		14	350
Right hip and knee extension and flexion	Option #1		26	300
Left hip and knee extension and flexion	Option #1		26	340

(Contd...)

Table 1: *(Continued)*.

Action	# Option	Electrodes	Frequency (Hz)	Pulse width (μs)
Bowel and bladder	Option #1		60	300
Bowel and bladder	Option #2		90	300

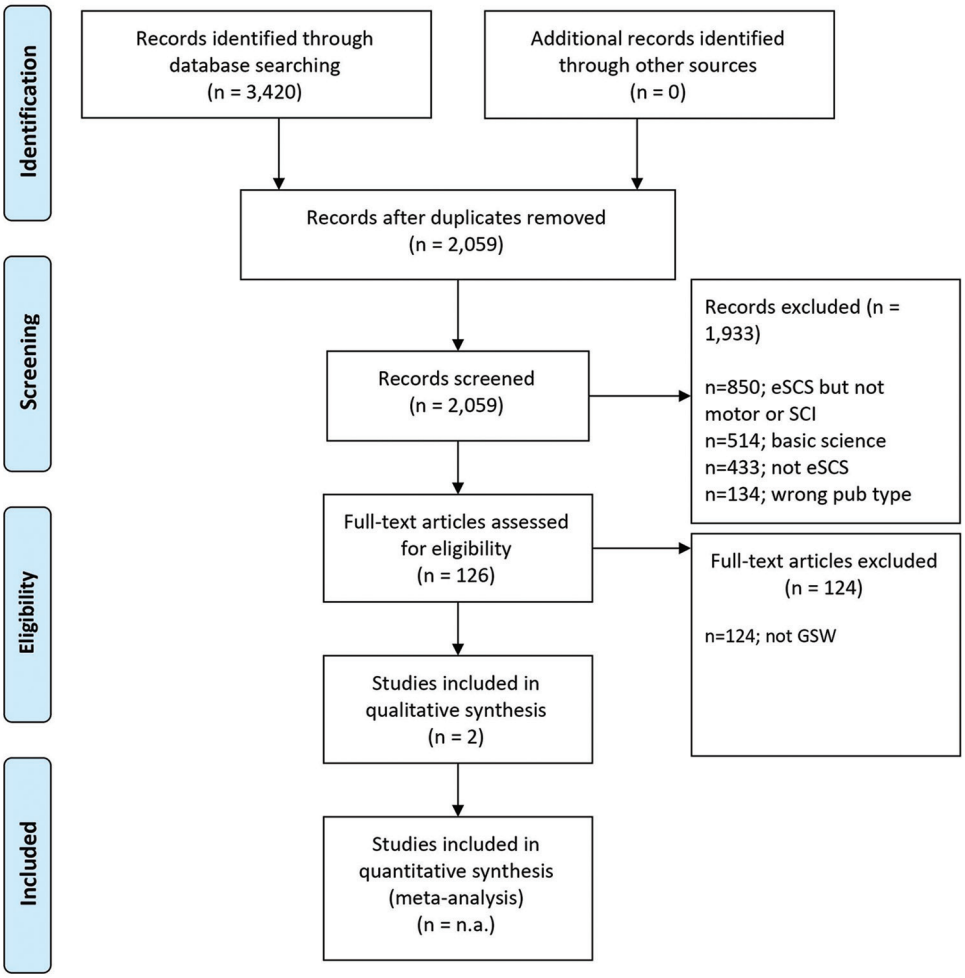

Figure 4: PRISMA diagram of literature search for previous literature on restoration of volitional movement in gunshot wound patients receiving epidural spinal cord stimulation.

Table 2: Literature search.

Name	Pt. no.	Age (yrs)	Gender	Level	Mos. post-injury	Preop. status	Postop. status
Richardson *et al*. 1979	1	13	Male	T11	1	SI, MC	SI, MI
Kandhari *et al*. 2022	2	27	Male	T2	24	ASIA-A	ASIA-C or D (n.s.)
	3	32	Male	T5	12	ASIA-A	ASIA-C or D (n.s.)
	4	40	Male	T9	7	ASIA-A	ASIA-C or D (n.s.)

Pt: Patient, no: Number, yrs: Years, mos.: Months, preop: Preoperative, postop: Postoperative, ASIA: American spinal injury association, n.s.: not specified, SI: Sensory incomplete, MC: Motor complete, MI: Motor incomplete

Video 1: First video of patient using epidural spinal cord stimulation along with assisted walking therapy.

Video 2: Second video of patient using epidural spinal cord stimulation along with assisted walking therapy.

placement. We identified four other patients in the literature discussing placement of eSCS for penetrating spinal GSW [Table 2], PRISMA flow diagram is shown in [Figure 4].[3,6]

Collectively, these cases suggest that eSCS may possibly have a role in improving outcomes in patients with pSCI; however, further research is necessary to confirm this.

CONCLUSION

This case study shows that a patient with a pSCI attributed to a GSW resulting in total loss of motor and sensory function can benefit from the placement of an epidural spinal cord stimulator.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

Dr. Samadani has equity in Oculogica and has received speaking fees from Integra. Abbott and Medtronic have made donations to the J Aron Allen Legacy Foundation, which has donated research money to the laboratory of Dr. Samadani. No other disclosures were reported.

REFERENCES

1. Avila MJ, Martirosyan NL, Hurlbert RJ, Dumont TM. Penetrating spinal cord injury in civilians: Analysis of a national database. World Neurosurg 2021;146:e985-92.
2. Bin-Alamer O, Bhenderu LS, Stuebe C, Sagoo NS, Palmisciano P, Haider M, *et al*. Penetrating spinal cord injury: A systematic review and meta-analysis of clinical features and treatment outcomes. Spinal Cord 2022;60:845-53.
3. Kandhari S, Sharma D, Samuel S, Sharma G, Majumdar P, Edgerton VR, *et al*. Epidural spinal stimulation enables global sensorimotor and autonomic function recovery after complete paralysis: 1st study from India. IEEE Trans Neural Syst Rehabil Eng 2022;30:2052-9.
4. Khorasanizadeh M, Yousefifard M, Eskian M, Lu Y, Chalangari M, Harrop JS, *et al*. Neurological recovery following traumatic spinal cord injury: A systematic review

and meta-analysis. J Neurosurg Spine 2019;30:683-99.
5. Platt A, Dafrawy MH, Lee MJ, Herman MH, Ramos E. Gunshot wounds to the lumbosacral spine: Systematic review and meta-analysis. Global Spine J 2022;12:1247-53.
6. Richardson RR, Cerullo LJ, McLone DG, Gutierrez FA, Lewis V. Percutaneous epidural neurostimulation in modulation of paraplegic spasticity. Six case reports. Acta Neurochir (Wien) 1979;49:235-43.
7. Roach MJ, Chen Y, Kelly ML. Comparing blunt and penetrating trauma in spinal cord injury: Analysis of long-term functional and neurological outcomes. Top Spinal Cord Inj Rehabil 2018;24:121-32.
8. Sidhu GS, Ghag A, Prokuski V, Vaccaro AR, Radcliff KE. Civilian gunshot injuries of the spinal cord: A systematic review of the current literature. Clin Orthop Relat Res 2013;471:3945-55.

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