

Original Article

POSTTRAUMATIC NEUROPATHIC PAIN FOLLOWING SPINAL CORD INJURY**Milan Spaić^{1,2}, Nada Marković³**¹ Department of Neurosurgery, Military Medical Academy, Belgrade, Serbia² Division of Neurosurgery, Clinical Hospital Centre, Zemun, Serbia³ Institute for Psychology and Mental Health, Military Medical Academy, Belgrade, Serbia**Received:** June 27, 2025; **Revised:** August 1, 2025; **Accepted:** August 2, 2025**Published:** August 12, 2025**DOI:** 10.5937/annnurs3-59798**Abstract**

Background: Severe posttraumatic neuropathic chronic pain in paralyzed limbs occurs in 10–30% of patients following spinal cord injury. Effective pain relief is a key prerequisite for successful rehabilitation in these individuals.

Aim: To identify different patterns of posttraumatic neuropathic pain and determine which pain features are most responsive to surgical intervention.

Materials and Methods: A consecutive series of 45 patients with gunshot-induced spinal cord injuries was analyzed for posttraumatic neuropathic pain, focusing on the nature and distribution of the pain. The standard McGill-Melzack Pain Questionnaire was used to assess pain characteristics, while pain distribution was recorded using body maps drawn by the patients. Two distinct pain qualities were identified: thermal (burning) and mechanical (cutting). Pain distribution was classified as either localized or diffuse. Dorsal Root Entry Zone (DREZ) lesion surgery was performed to achieve pain relief.

Results: There were 21 patients (47%) suffering from pain of mechanical nature, 7 patients (15%) experiencing pain of pure thermal nature, and 17 patients (38%) with combined mechanical and thermal pain. There were 38 patients (85%) who reported localized pain, while 7 patients (15%) experienced diffuse pain. Pain relief was achieved in all patients with localized pain, regardless of whether the pain was thermal or mechanical. In contrast, DREZ surgery was ineffective in patients with diffuse pain.

Conclusion: Localized posttraumatic neuropathic pain was the most common pattern observed in patients following spinal cord injury and showed the highest responsiveness to DREZ surgery. In contrast, diffuse pain demonstrated poor responsiveness to this surgical intervention.

Keywords: neuropathic pain, spinal cord injuries, neurosurgery

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Introduction

Spinal cord injury resulting in paraplegia is considered one of the most devastating conditions in human pathology.¹ Even more debilitating than the paralysis itself is the chronic neuropathic pain that often accompanies such injuries.² The syndrome of severe posttraumatic neuropathic chronic pain in paralyzed limbs affects approximately 10–30% of individuals with spinal cord injuries.³

Neuropathic pain is defined as pain arising from damage to or dysfunction of the central nervous system. Unlike nociceptive (physiological) pain—which results from activation of nociceptors in an otherwise intact nervous system—neuropathic pain occurs independently of nociceptor activation.⁴ As a result, neuropathic pain lacks the protective or warning function that nociceptive pain serves in normal sensory physiology. It should therefore be considered a pathological condition in its own right, with a significant impact on the psychological well-being of affected individuals.

Pain perceived in paralyzed and anesthetic limbs is often difficult to explain or understand, leading to the use of the term *phantom pain*.⁴ Paraplegic patients who suffer from such pain represent a complex psychological, social, and medical challenge. The disability associated with chronic, severe pain frequently leads to secondary psychiatric disorders.² Consequently, effective pain relief is essential for successful rehabilitation following spinal cord injury.

The primary therapeutic goal in paraplegic patients is to achieve pain relief and restore functional quality of life. It is therefore of major clinical importance to recognize neuropathic pain in the posttraumatic period and to accurately define the specific pain syndrome.⁵ Once the pain type is identified, an appropriate treatment approach can be selected. In this regard, medical professionals must be adequately informed and trained to recognize neuropathic pain syndromes.

Although rare in civilian practice, this type of pain becomes increasingly common in wartime settings, reaching epidemic proportions due to firearm- or shrapnel-induced spinal injuries. The pain is often

more severe in such cases compared to other traumatic causes, owing to the extensive tissue damage caused by high-energy projectiles.⁶

The aim of this investigation was to identify distinct patterns of posttraumatic neuropathic pain and determine which pain characteristics are most responsive to surgical treatment.

Materials and Methods

Between April 1997 and December 2019, a total of 45 male patients, aged 22 to 57 years (mean age: 38 years), were admitted for assessment and treatment of pain resulting from spinal cord injuries caused by gunshot wounds sustained during wartime.

Pain assessment was conducted using the McGill–Melzack Pain Questionnaire, which includes a list of 47 pain descriptors.⁷ The topography of the pain was determined using pain diagrams drawn by the patients. Pain intensity was evaluated using the Visual Analogue Scale (VAS).

All the patients were tested psychologically with the Minnesota Multiphasic Personality Inventory (MMPI).⁸

All patients underwent Dorsal Root Entry Zone (DREZ) lesion surgery for pain relief. The surgical indication was established when the following criteria were met:

Pain had persisted for at least six months. Pain severity disrupted daily functioning and sleep. Regular use of analgesic and/or narcotic therapy was required for pain control. Postoperative pain relief was assessed by comparing preoperative and postoperative VAS scores, as reported by the patients.

Complete pain relief was considered the optimal surgical outcome. However, if a patient reported at least a 50% reduction in pain intensity—such that regular analgesic therapy was no longer needed—the result was categorized as favorable. Outcomes showing no improvement or less than 50% reduction in pain intensity were classified as unsuccessful.

This study focused on the immediate surgical outcomes in relation to different pain patterns.

Pain Description

Patients presented with two distinct types of pain: Thermal pain, described using terms such as burning, boiling, and baking; Mechanical pain, described using terms such as cutting, shooting, incisive, constricting, etc. When both thermal and mechanical descriptors were reported in the same pain area, the condition was classified as a mechanothermal pain syndrome.²

Pain distribution was categorized as either localized (confined within specific dermatomal boundaries), or diffuse (experienced throughout the body below the level of spinal cord injury).

Statistical Analysis

Chi-square tests were used to analyze categorical data. A p -value < 0.05 was considered statistically significant.

Results

Among the 45 patients, 21 (47%) experienced pain of mechanical nature, 17 (38%) reported combined mechanical and thermal pain, and 7 (15%) suffered from pure thermal pain.

In terms of pain distribution, 38 patients (85%) had pain confined to a localized territory, while 7 patients (15%) reported diffuse pain affecting the entire body below the level of injury (Figures 1 and 2). Notably, all 7 patients with diffuse pain experienced pure thermal pain, whereas mechanical and mechanothermal pain types were exclusively associated with localized territories (Table 1)

A statistically significant association was observed between the thermal nature of pain and diffuse pain distribution ($p < 0.05$). Additionally, injuries at the T10–L5 vertebral levels, specifically involving the conus medullaris and cauda equina, were significantly associated with the highest intensity of neuropathic pain in this cohort.

Of the 38 patients with localized pain, all experienced significant pain relief following DREZ surgery. In contrast, none of the 7 patients with diffuse pain reported satisfactory pain relief postoperatively. The difference in surgical outcomes between patients with localized versus diffuse pain was statistically significant, with localized pain patterns showing a markedly better response to DREZ intervention.

Psychological testing revealed elevated levels of anxiety, depression, and hypochondriasis in all patients, regardless of pain type or surgical outcome.

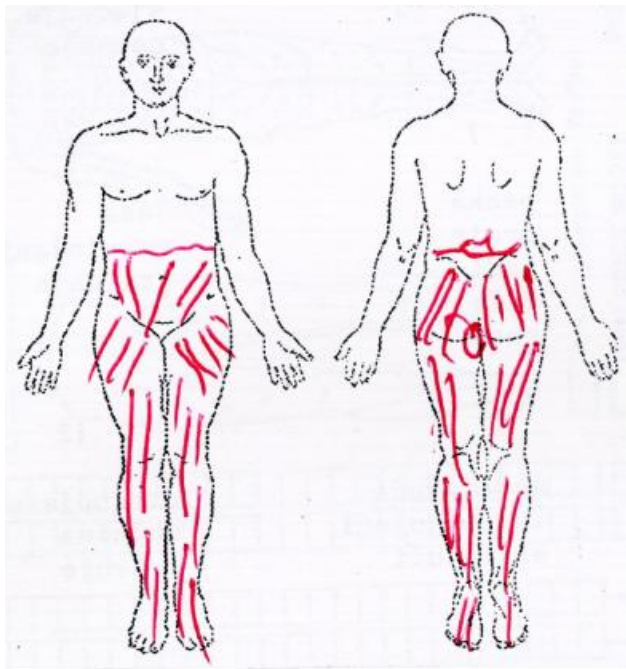


Figure 1. Patient-drawn pain diagram indicating diffuse neuropathic pain

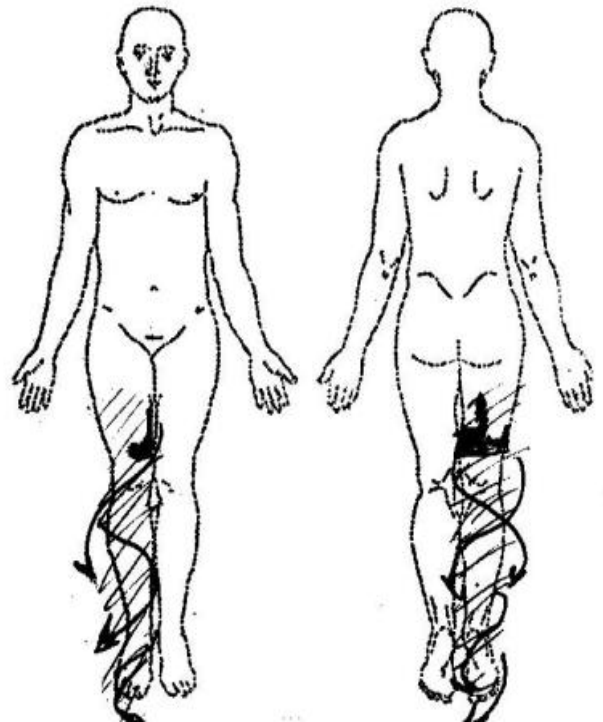


Figure 2. Pain topography drawing by a patient showing diffuse pain distribution

Table 1. Preoperative Characteristics of Pain after Spinal Cord Gunshot Injuries and Pain Relief Following DREZ Lesion Surgery (n = 45 Patients)*

Pain Area	Pain Nature /n (%)/			VAS ^{##}	Pain Relief after DREZ ^{##}	
				Mean	/ n (%)/	
	M [#]	T\$	C ^{**}		Complete	Failed
Localized /38 (84)	21 (55)	0	17 (45)	8.8	38 (100)	0
Diffuse /7 (16)	0	7 (100)	0	7.3	0	38 (100)

*Dorsal Root Entry Zone lesion surgery; #Mechanical ; \$ Thermal; ** Combined; ##Visual Analogue Scale

Discussion

Chronic posttraumatic paraplegic pain syndrome can present with variable onset intervals and diverse patterns of expression.^{9,10} In our group of patients, the onset of pain occurred: Immediately at the time of injury in 6 patients (14%), Within several days to one month in 23 patients (50%), and Between one month and one year post-injury in 16 patients (36%).

No cases were recorded in which pain began more than one year after the injury.

The rapid psychological decline driven by chronic pain necessitates early and effective treatment. Neuropathic pain has been shown to result from spontaneous discharges of dorsal horn neurons within the injured segments of the spinal cord.^{11,12,13,14} These discharges, caused by trauma-induced damage, have been referred to as "spinal epilepsy."¹⁵ In response, a targeted surgical procedure known as DREZ (Dorsal Root Entry Zone) lesion surgery was developed, involving ablation of the dorsal horn in selected spinal cord segments.¹⁶

It has also been confirmed that different patterns of neuropathic pain arise from distinct neurogenic mechanisms and anatomical origins. Pain localized to a confined territory typically results from spinal-level mechanisms, particularly spontaneous discharges of dorsal horn neurons. As such, this pain pattern is highly responsive to DREZ surgery.

Conversely, diffuse pain has been associated with posttraumatic alterations in thalamocortical transmission, a supraspinal mechanism.¹⁷ Accordingly, this form of pain is not amenable to spinal surgery. For this reason, it is of utmost clinical importance to accurately identify and define both the nature and topography of neuropathic pain early in the posttraumatic course, in order to select patients who are likely to benefit from surgical intervention—specifically those experiencing localized neuropathic pain.

The effectiveness of DREZ surgery in treating pain confined to a localized territory has been previously reported.^{18,19,20,21} The first essential

step in patient evaluation is simple yet critical: to assess the pattern of chronic pain, with a primary focus on pain topography—whether it is localized or diffuse. Medical professionals treating paraplegic patients with neuropathic pain must ensure they ask the patient for a detailed pain description, especially regarding pain distribution.

Once pain topography is established, appropriate treatment can be selected. Localized pain has been confirmed as the best surgical indication for DREZ intervention. In our cohort, only 7 patients (15%) experienced diffuse pain affecting the entire body below the level of injury, and none of them responded favorably to DREZ surgery. These patients typically described their pain as feeling like their body was "submerged in boiling oil." In contrast, 85% of patients, all with localized pain, experienced significant and sustained pain relief after DREZ surgery. This outcome represents a critical step in restoring functional life, as pain relief is a prerequisite for successful rehabilitation.

Conclusion

Neuropathic pain in paraplegic patients should be addressed promptly, before psychological deterioration occurs. Pain confined to a localized territory was the most responsive pattern to DREZ surgery, whereas diffuse pain of pure thermal nature did not respond to this surgical approach.

Conflict of Interest

The authors declare no conflict of interest.

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