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Article

Evaluation of the Relationship Between Pain and Functional Status, Depression, Anxiety and Quality of Life in Patients with Spinal Cord Injury: Neuropathic Pain in Spinal Cord Injury

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Abstract

Background: Neuropathic pain is a common and challenging complication following spinal cord injury (SCI). It significantly affects patients' physical, psychological, and social well-being, often leading to impaired quality of life and increased emotional distress. **Objectives:** To determine the prevalence of neuropathic pain in patients with SCI, evaluate its relationship with clinical and demographic characteristics, and examine its associations with quality of life, depression, and anxiety. **Methods:** Eighty-four patients with SCI who were admitted to the Department of Physical Medicine and Rehabilitation and followed up at the rehabilitation outpatient clinic of Dicle University Medical Faculty Hospital (Diyarbakır, Turkey) were included. Neurological status was assessed using the American Spinal Injury Association (ASIA) scale. Functional ambulation was evaluated by the Walking Index for Spinal Cord Injury (WISCI) and Functional Ambulation Scale (FAS), while independence was assessed with the Spinal Cord Independence Measure version 3 (SCIM-III). Quality of life was measured using the Short Form-36 (SF-36). Depression and anxiety were evaluated by the Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI). Neuropathic pain, fatigue, and paresthesia severity were assessed using the Visual Analog Scale (VAS) and the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) questionnaire. **Results:** Neuropathic pain was identified in 41.7% of patients. No significant differences were observed in age, gender, or marital status between those with and without neuropathic pain. Patients with neuropathic pain had significantly higher BAI scores and lower scores in several SF-36 domains, including vitality, bodily pain, and emotional well-being. LANSS scores correlated positively with VAS fatigue, BAI scores, and negatively with SF-36 domains such as vitality, general health, and bodily pain. **Conclusions:** Neuropathic pain is a frequent and burdensome complication after SCI, strongly associated with reduced quality of life and increased psychological distress, particularly anxiety. Early recognition and management of neuropathic pain are essential to improve functional and psychosocial outcomes in patients with SCI.

Keywords: spinal cord injury; neuropathic pain; quality of life; anxiety; depression; functional outcomes; LANSS

1. Introduction

Spinal cord injury (SCI) is a debilitating and life-altering condition that not only impairs motor and sensory functions but also profoundly affects the individual's psychological well-being, autonomy, and social relationships. The consequences of SCI extend beyond the physical, influencing personality, emotional stability, and the dynamics within family and community environments. In addition to these psychosocial burdens, SCI presents complex medical challenges that require long-term, multidisciplinary management. These may include chronic pain, spasticity, pressure ulcers, urinary and bowel dysfunction, and increased risk of infections.

Despite these challenges, significant advancements in medical care, rehabilitation techniques, and assistive technologies over the past decades have led to improved functional outcomes, enhanced quality of life, and increased life expectancy in individuals living with SCI [1,2]. As a result, there is a growing emphasis not only on survival but also on optimizing physical function, mental health, and social integration among this population.

Following spinal cord injury (SCI), one of the most immediate and profound impairments is the loss of motor function. However, neuropathic pain (NP) represents a common and particularly distressing complication that often develops either acutely or chronically after the injury. This type of pain can significantly affect functional capacity, psychological well-being, and overall quality of life. Post-SCI pain presents with various etiologies and clinical manifestations, and it may emerge immediately after the injury or manifest months to even years later. Despite its prevalence and impact, there remains no universal consensus among researchers and clinicians regarding the classification, diagnosis, or prevalence rates of the various pain types observed in SCI populations [3,4].

Chronic pain is highly prevalent in individuals with SCI, with reported rates ranging from 11% to 94%, depending on study populations and diagnostic criteria [5,6]. Of those experiencing chronic pain, approximately 30% are diagnosed with neuropathic pain [5]. According to the Spinal Cord Injury Pain Task Force of the International Association for the Study of Pain (IASP), pain in individuals with SCI is broadly classified into two main categories: nociceptive pain and neuropathic pain [7]. Neuropathic pain, unlike nociceptive pain, does not arise from external tissue injury but is instead thought to originate from pathological processes within the central or peripheral nervous system due to the lesion itself [8].

Neuropathic pain (NP) exerts profound effects on multiple facets of an individual's well-being. It is frequently associated with mood alterations, heightened anxiety, and sleep disturbances, all of which can exacerbate the subjective experience of pain itself. Disruptions in sleep and the presence of depressive symptoms often interfere with patients' ability to engage effectively in activities of daily living, potentially contributing to increased disability [9,10]. Beyond the direct consequences of motor impairment, these psychological and behavioral factors further diminish patients' capacity to participate actively in rehabilitation programs and delay their reintegration into work or other productive roles. This underscores the complex, bidirectional interplay between pain, mental health, and functional outcomes in individuals suffering from neuropathic pain after spinal cord injury (SCI). Neuropathic pain in SCI patients represents a considerable clinical challenge, limiting functional independence and substantially impairing quality of life [11]. The primary objective of our study was to determine the prevalence of neuropathic pain among individuals with SCI and to investigate its associations with demographic and clinical characteristics. Additionally, we aimed to evaluate the relationships between neuropathic pain, functional status, quality of life, and psychological factors such as anxiety and depression in this population. Through this comprehensive approach, we sought to deepen the understanding of neuropathic pain's multifaceted impact in SCI and to provide insights that may guide the development of more effective, targeted management strategies.

2. Materials and Methods

2.1. Study Design and Study Population

Eighty-four patients diagnosed with spinal cord injury (SCI), who were either admitted to the Physical Therapy and Rehabilitation Department at Dicle University Medical Faculty Hospital or followed in the rehabilitation outpatient clinic, were included in this study. Informed consent was obtained from all patients prior to their inclusion in the study. The study protocol was reviewed and approved by the Ethics Committee of Dicle University Faculty of Medicine. A comprehensive assessment protocol was implemented, encompassing physical and neurological examinations as well as pain evaluation. Demographic data, including age, sex, injury date, etiology, and disease duration, were collected using a structured questionnaire.

Neurological status was assessed utilizing the American Spinal Injury Association (ASIA) scale, enabling detailed evaluation of sensory and motor levels [12]. Functional ambulation was measured by the Walking Index for Spinal Cord Injury (WISCI), while overall functional independence was evaluated through the Spinal Cord Independence Measure version 3 (SCIM-III) [13,14]. These standardized assessments provided a thorough characterization of the patients' neurological deficits, functional capabilities, and independence levels following SCI.

The quality of life of the patients was assessed using the Short Form-36 Health Survey (SF-36) questionnaire [15]. To evaluate the severity and presence of depression and anxiety, the Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI) were administered [16,17]. Pain assessment was performed for all participants, with neuropathic pain diagnosis established based on detailed medical history and clinical examination findings. Patients were subsequently categorized into two groups: those with neuropathic pain and those without. For the neuropathic pain group, the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) scale was utilized to further characterize pain features [18]. Pain intensity was quantified using the Visual Analog Scale (VAS) [19].

To maintain a homogeneous and focused study population, several exclusion criteria were applied. Patients younger than 16 years, those with impaired cognitive function or inability to cooperate with study procedures, were excluded. Additionally, individuals with pre-existing organ or nerve injuries, unstable clinical conditions, or comorbidities such as diabetes mellitus that could independently contribute to neuropathic pain were not included. Patients in the acute phase of spinal cord injury or those experiencing spinal shock were also excluded. These exclusion criteria aimed to reduce confounding variables, thereby enhancing the internal validity of the study. By eliminating participants with factors potentially affecting neuropathic pain or those unable to provide reliable data, the study sought to improve the accuracy and reliability of its findings.

2.2. Statistical Analysis

Statistical analysis was conducted using the SPSS for Windows software package, version 21.0. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Continuous variables with normal distribution were expressed as mean $\pm$ standard deviation (SD) and compared between groups using the Student's t-test. For variables that did not meet the assumptions of normality, non-parametric tests, specifically the Mann-Whitney U test, were employed to compare differences between groups. Categorical variables were analyzed using the Chi-square test or Fisher's exact test when appropriate, to assess associations and differences in proportions. Correlation analyses were performed to explore the relationships between neuropathic pain severity and various clinical parameters. Both Pearson's correlation coefficient was used for normally distributed continuous variables, and Spearman's rank correlation coefficient was applied for non-normally distributed data or ordinal variables. This dual approach allowed for robust assessment of linear and monotonic relationships. Statistical significance was set at a p-value of less than 0.05 for all analyses. In addition, where multiple comparisons were conducted, appropriate adjustments or considerations were made to control for type I error. The results of statistical tests were interpreted in the context of clinical relevance as well as statistical significance to provide comprehensive insight into the data.

3. Results

A total of 84 patients diagnosed with spinal cord injury (SCI) were included in the study. Among the participants, 66.7% (n=56) were male. The mean age was 36.76 ± 14.4 years, ranging from 16 to 70 years. The average disease duration was 30 months, with a wide range from 6 to 480 months. Regarding marital status, 63.1% (n=53) of patients were married (Table 1).

Table 1. Mean demographic, SCIM 3, BDI, BAI and SF-36 values of the patients.

Parameters	Mean
Age (Year)	36,76 ± 14,4 (16-70)
Gender (M/F)	56/28
Marital Status (Married/Single)	53/31
Disease Duration (Months)	Median 30 (6-480)
SCIM 3 score	65,95±25,98
BDI score	20,26±11,26
BAI score	15,98±9,91
SF-36 score	40,54±21,35

SCIM 3 score; Spinal Cord Independence Measure 3 score, BDI score; Beck Depression Inventory score, BAI score; Beck Anxiety Inventory score, SF-36; Short Form 36 Health Survey score

Educational status varied among the participants: 20.2% (n=17) were illiterate, 26.2% (n=22) had completed primary school, 16.7% (n=14) secondary school, 34.5% (n=29) high school, and 2.4% (n=2) held a university degree. Occupationally, only 7.1% (n=6) of patients were actively employed, whereas 92.9% (n=78) were unemployed at the time of assessment. Regarding the etiology of SCI, 66.7% (n=56) had traumatic causes, predominantly due to accidents or injuries, while 33.3% (n=28) suffered from non-traumatic etiologies such as medical or disease-related conditions. Among traumatic causes, falls from height were the most frequent (33.3%, n=28), followed by traffic accidents (16.7%, n=14). Notably, iatrogenic injuries accounted for 10% (n=8) of cases.

Neurological classification according to the American Spinal Injury Association (ASIA) scale revealed that 35.7% (n=30) of patients had sensory complete injuries, whereas 64.3% (n=54) had sensory incomplete lesions. In terms of motor function, 11.9% (n=10) were tetraplegic, and the majority, 88.1% (n=74), were paraplegic.

These demographic and clinical characteristics provide a comprehensive overview of the study population, reflecting the diversity in etiology, neurological impairment, and socioeconomic status among patients with SCI.

When assessing complications among the patients, it was observed that 31% (n=26) exhibited spasticity, characterized by involuntary muscle contractions commonly associated with spinal cord injury (SCI). Additionally, pressure ulcers were present in 14.3% (n=12) of patients; these localized lesions result from prolonged pressure causing damage to the skin and underlying tissues.

The patients’ functional and psychological assessment scores—including the Walking Index for Spinal Cord Injury (WISCI), Spinal Cord Independence Measure version 3 (SCIMIII), Short Form-36 Health Survey (SF-36), Beck Depression Inventory (BDI), and Beck Anxiety Inventory (BAI)—are summarized in Table 1.

Neuropathic pain was identified in 41.7% (n=35) of the cohort, while 58.3% (n=49) reported no neuropathic pain. Among patients with neuropathic pain, 74.3% were male and 25.7% were female. Conversely, in the group without neuropathic pain, 61.2% were male and 38.8% were female. Regarding marital status, 71.4% of patients with neuropathic pain were married compared to 57.1% in the painless group. No statistically significant differences were observed between the neuropathic pain and painless groups in terms of age, gender, or marital status (p > 0.05) (Table 2).

Table 2. Demographic characteristics of the patients with neuropathic pain and non-painful group.

Parameters	Neuropathic Pain Group n=35)	Painless Group (n=49)	<i>p</i>
Age (Year)	38,85±13.3	35,26±15,09	0.81
Gender (M/F)	26/9	30/19	0.247
Married/Single	25/10	28/21	0.054

Comparison of educational status between groups revealed no significant differences. The mean disease duration was 24 months (range: 6–480 months) in the neuropathic pain group and 16 months (range: 6–480 months) in the painless group, with no statistically significant difference noted.

No significant differences were found between groups regarding neurological level or etiological classification (traumatic versus non-traumatic causes). Within the neuropathic pain group, 40% (n=14) were classified as having complete SCI according to the ASIA scale, while 60% (n=21) had incomplete SCI. In the painless group, 32.7% (n=16) had complete SCI, and 67.3% (n=33) had incomplete SCI. Regarding motor function level, 11.4% (n=4) of patients with neuropathic pain were tetraplegic and 88.6% (n=31) were paraplegic. In the painless group, 12.2% (n=6) were tetraplegic, and 88.8% (n=43) were paraplegic. Statistical comparison showed no significant difference in neurological level or completeness of injury between the two groups ($p > 0.05$).

The mean Beck Depression Inventory (BDI), Beck Anxiety Inventory (BAI), and Short Form-36 (SF-36) scores of the patient groups are summarized and compared in Table 3. The mean Spinal Cord Independence Measure version 3 (SCIM-III) score was 63.2 ± 26.3 in patients with neuropathic pain and 67.91 ± 25.84 in the painless group, with no statistically significant difference observed ($p > 0.05$). Similarly, functional ambulation levels, assessed by the Walking Index for Spinal Cord Injury (WISCI), yielded mean scores of 10.97 ± 7.6 and 11.75 ± 7.47 for the neuropathic pain and painless groups, respectively. The difference between these groups was also not statistically significant ($p > 0.05$) (Table 3).

Table 3. BAI and SF-36 scores of the groups.

Parameters	Painful Group (n=35)	Painless Group (n=49)	<i>p</i>
General health	39,4±19,88	41,77±24,16	0.634
Vitality	28,38±25,80	40,10±26,48	0.047*
Social functioning	37,54±31,08	45,91±35,84	0.269
Role emotional	30,72±40,26	64,34±47,52	0.022*
Mental health	50,17±23,28	60,06±26,43	0.080
Physical capacity	47,60±48,56	55,10±50,25	0.496
Bodily pain	28,70±19,46	51,53±24,71	0.000**
Physical functioning	3,14±7,08	8,46±16,58	0.078
Total SF-36 score	33,14±18,70	45,82±21,73	0.007*
BDI score	22,28±11,61	18,81±10,90	0.166
BAI score	18,17±10,30	14,42±9,42	0.048*

SF-36; Short Form 36 Health Survey score, Beck Depression Inventory score, BAI score; Beck Anxiety Inventory score

Comparing psychological and quality of life measures, the neuropathic pain group had a mean BDI score of 22.28 ± 11.61 , compared to 18.81 ± 10.9 in the painless group. The mean BAI score was higher in the neuropathic pain group (18.17 ± 10.3) versus the painless group (14.42 ± 9.42). The total SF-36 quality of life score was significantly lower in the neuropathic pain group (33.14 ± 18.7) compared to the painless group (45.82 ± 21.73). Statistically significant differences were observed between the groups in the domains of vitality, emotional well-being, bodily pain, and overall SF-36 score ($p < 0.05$). These findings suggest that patients experiencing neuropathic pain report higher levels of depression and anxiety, alongside poorer quality of life relative to those without neuropathic pain (Table 3).

Correlation analyses between the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) pain score and variables including age, BDI, BAI, ASIA scale, SCIM-III, WISCI, SF-36 domains, and Visual Analog Scale (VAS) scores for pain and fatigue are detailed in Table 4. The LANSS score demonstrated a significant positive correlation with BAI scores ($r = 0.323$, $p = 0.003$) and significant negative correlations with total SF-36 score ($r = -0.544$, $p = 0.000$), bodily pain ($r = -0.544$, $p = 0.000$), vitality ($r = -0.351$, $p = 0.001$), social functioning ($r = -0.259$, $p = 0.017$), emotional role ($r = -0.286$, $p = 0.008$), and mental health ($r = -0.299$, $p = 0.006$). No significant correlations were found between the LANSS score and BDI ($r = 0.188$, $p = 0.087$), SCIM-III ($r = 0.111$, $p = 0.316$), ASIA scale ($r = 0.166$, $p = 0.132$), WISCI score ($r = 0.118$, $p = 0.283$), or age ($r = 0.137$, $p = 0.214$). These results indicate that neuropathic pain severity is positively associated with anxiety and negatively associated with multiple quality of life domains, but shows no significant relationship with depression, neurological impairment, functional independence, ambulation, or age.

The mean VAS pain score in the neuropathic pain group was 6.94 ± 2.09 , indicating moderate pain intensity. The difference in VAS pain scores between the neuropathic pain and painless groups was statistically significant ($p = 0.001$). Similarly, the mean VAS fatigue score was 7.05 ± 2.2 in the neuropathic pain group, reflecting moderate fatigue, with this difference also reaching statistical significance compared to the painless group ($p = 0.027$). The mean VAS paresthesia score in the neuropathic pain group was 8.05 ± 1.57 , indicating a relatively high level of paresthesia, with a statistically significant difference from the painless group ($p = 0.000$) (Table 4). When queried about the character of their neuropathic pain, 39.3% of patients ($n = 33$) described their pain as "burning".

Table 4. Correlation analysis between LANSS Pain Score and clinical parameters.

Parameters (n=84)	<i>r</i>	<i>p</i>
SCIM 3	-0.111	0.316
BDI	0.188	0.087
BAI	0.323	0.003**
SF 36 TOTAL	-0.421	0.000**
SF 36 Vitality	-0.351	0.001**
SF 36 Bodily pain	-0.544	0.000**
SF 36 Social functioning	-0.259	0.017*
SF 36 Emotional role	-0.286	0.008**
SF 36 Mental health	-0.299	0.006**
VAS Fatigue	0.323	0.003**
Age	0.237	0.214
WISCI	0.118	0.283

LANSS; Leeds Assessment of Neuropathic Symptoms and Signs Pain Scale, BDI; Beck Depression Inventory score, BAI score; Beck Anxiety Inventory score, SF-36; Short Form 36 Health Survey score, VAS; Visual Analogue Scale, WISCI; Walkin Index for Spinal Cord Injury

4. Discussion

Neuropathic pain in individuals with spinal cord injury (SCI) is a complex and challenging condition that significantly impacts patients' well-being and daily functioning. Unlike nociceptive pain, which arises from tissue damage or inflammation, neuropathic pain results from dysfunction or injury to the nervous system. In SCI patients, neuropathic pain may present as burning, tingling, shooting, or electric shock-like sensations, often localized below the level of injury and sometimes extending to the extremities. The intensity and persistence of this pain can vary widely, with some individuals experiencing constant symptoms and others suffering from intermittent episodes [20].

The prevalence of neuropathic pain in our cohort (41.7%) is consistent with rates reported in previous studies. For instance, Siddall et al. found a similar prevalence of approximately 40% among individuals with chronic SCI [21]. Furthermore, a systematic review by Finnerup et al. reported a

broad prevalence range from 11% to 96%, reflecting considerable variability across studies due to differences in study design, patient populations, and methods of pain assessment [22]. Despite this variability, the data collectively affirm that neuropathic pain is a substantial and prevalent problem among individuals living with SCI.

In line with our findings, several prior investigations have observed no significant associations between neuropathic pain and demographic factors such as age, gender, or marital status [21,23,24]. These results suggest that the occurrence of neuropathic pain in SCI patients is not strongly dependent on these demographic characteristics. However, it should be noted that pain perception is inherently subjective and influenced by a variety of individual, psychological, and social factors, which may contribute to the lack of consistent associations.

Regarding disease-related variables, we found no significant difference in SCI duration between patients with and without neuropathic pain. This aligns with other studies reporting no clear relationship between the length of time since injury and the prevalence of neuropathic pain [24]. Conversely, some research indicates that chronicity of SCI might play a role in the onset and persistence of neuropathic pain [25]. Therefore, further longitudinal studies with larger sample sizes are warranted to clarify the complex dynamics between disease duration and neuropathic pain development in SCI populations.

The etiology of spinal cord injury (SCI) has been investigated as a potential factor influencing the development of neuropathic pain. In our study, no significant difference was observed between traumatic and non-traumatic causes regarding the presence of neuropathic pain. This finding aligns with previous research that similarly failed to demonstrate a clear association between SCI etiology and neuropathic pain prevalence [21,23,24]. The pathophysiology underlying neuropathic pain post-SCI is multifactorial and complex, involving both peripheral and central sensitization mechanisms. Therefore, the specific cause of the injury may not be the predominant determinant in the development of neuropathic pain.

Regarding neurological classification, our results indicated no significant differences in terms of injury completeness or neurological level between patients with and without neuropathic pain. These results corroborate conclusions from systematic reviews which have reported that neuropathic pain is not strongly correlated with the severity or level of SCI [25]. Nonetheless, it is important to consider that individual differences in pain processing, as well as the involvement of distinct sensory pathways, may play critical roles in neuropathic pain manifestation regardless of the anatomical level or completeness of the lesion.

Our study further highlights the substantial impact of neuropathic pain on mental health and quality of life. Patients experiencing neuropathic pain demonstrated significantly elevated levels of depression and anxiety, along with poorer scores across multiple domains of the SF-36 health survey. These findings are consistent with prior studies underscoring the detrimental psychological and functional consequences of neuropathic pain in individuals with SCI [21,24,25]. Chronic pain can exacerbate emotional distress, promote social withdrawal, and diminish overall functioning, emphasizing the necessity for multidisciplinary pain management strategies that holistically address both the physical and psychological components of care.

An important consideration in neuropathic pain research is the selection of assessment tools. In our study, the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) scale was employed, a tool widely utilized in SCI populations [22,25]. However, alternative validated instruments, such as the Neuropathic Pain Scale (NPS) and the Douleur Neuropathique en 4 Questions (DN4), are available and may offer a more nuanced characterization of neuropathic pain features. Future studies could benefit from incorporating multiple assessment modalities to enhance the robustness of neuropathic pain evaluation.

The results of this study revealed notable associations between the LANSS pain score and various psychological and quality of life parameters in patients with spinal cord injury (SCI). Specifically, the LANSS pain score exhibited a significant positive correlation with the Beck Anxiety Inventory (BAI) score, indicating that higher neuropathic pain severity was associated with increased

anxiety levels. This finding suggests that anxiety may amplify the perception and experience of neuropathic pain, thereby exacerbating its detrimental effects on the individual's overall well-being. The observed positive correlation between LANSS scores and anxiety is consistent with previous research highlighting the bidirectional relationship between pain and anxiety in SCI populations [30].

Moreover, the LANSS pain score demonstrated significant negative correlations with multiple domains of the SF-36 quality of life questionnaire, including bodily pain, vitality, social functioning, emotional role, and mental health. These findings imply that elevated neuropathic pain levels are linked to diminished overall quality of life and impaired functioning across both physical and psychosocial domains. This underscores the multidimensional burden of neuropathic pain, affecting not only sensory and physical health but also emotional well-being, social participation, and mental health status. Numerous studies have corroborated the profound negative impact of neuropathic pain on quality of life metrics [31,32].

Interestingly, no significant correlations were identified between the LANSS pain score and depression (as measured by BDI), neurological injury level, functional independence (SCIM III), ambulation status (WISCI), or age. These findings suggest that neuropathic pain severity, as assessed by LANSS, may not be directly influenced by these clinical or demographic factors within this patient cohort. It may indicate that other unmeasured variables, such as central sensitization, psychosocial factors, or individual pain coping mechanisms, could play a more critical role in determining pain intensity. This lack of association with depression, neurological level, functional status, and age aligns with prior studies reporting similar findings [33,34].

The Visual Analog Scale (VAS) assessments for pain and fatigue further elucidate the subjective experiences of individuals with neuropathic pain following SCI. The significantly higher VAS pain and fatigue scores in the neuropathic pain group compared to the painless group emphasize the substantial impact of these symptoms on daily functioning and quality of life.

Moderate pain intensity reported on the VAS by neuropathic pain patients indicates that pain is a prevalent and impactful symptom in this population, consistent with previous literature documenting high neuropathic pain prevalence and severity among SCI patients [21,25]. This highlights the critical need for effective pain management strategies that address both the sensory-discriminative and affective-emotional components of pain to improve patient outcomes.

Similarly, moderate levels of fatigue identified in the neuropathic pain group underscore fatigue as a prevalent symptom that can severely affect functional abilities and quality of life. The recognized association between neuropathic pain and increased fatigue in SCI patients suggests that pain may contribute to the exacerbation of fatigue symptoms [21,26]. Thus, comprehensive care approaches should address both pain and fatigue concurrently to optimize rehabilitation outcomes and enhance patients' energy and functional capacity.

The significant differences observed in VAS pain and fatigue scores between groups highlight the clinical importance of recognizing and targeting these symptoms. Healthcare providers should adopt comprehensive assessment tools and multimodal intervention strategies, including pharmacologic treatments (e.g., analgesics, agents targeting neuropathic pain, and fatigue-reducing medications) as well as non-pharmacologic therapies (e.g., physical therapy, exercise programs, cognitive-behavioral therapy), to effectively manage neuropathic pain and associated fatigue in SCI patients.

Furthermore, the subjective nature of pain and fatigue underscores the necessity of a patient-centered approach when tailoring interventions. Regular and systematic assessments of pain and fatigue levels, coupled with ongoing communication with patients, are essential to guide individualized treatment modifications and optimize clinical outcomes. By proactively addressing both pain and fatigue in individuals suffering from neuropathic pain, healthcare providers can significantly enhance patients' overall well-being, functional capacity, and quality of life.

Regarding the management of neuropathic pain in SCI, although our study did not specifically investigate treatment modalities, it is important to recognize that managing neuropathic pain in this population remains a clinical challenge due to its complex and multifactorial nature. Current

therapeutic approaches generally involve multimodal strategies, including pharmacological agents such as anticonvulsants, antidepressants, and opioids, alongside non-pharmacological treatments like physical therapy, psychological support, and neurostimulation techniques [22,24].

There has been increasing interest in alternative and complementary therapies aimed at neuropathic pain relief in SCI patients. Modalities such as transcutaneous electrical nerve stimulation (TENS), acupuncture, and cognitive-behavioral therapy (CBT) are among the approaches being explored. Although evidence for their efficacy in SCI-related neuropathic pain is still preliminary, emerging studies have demonstrated promising outcomes [27,28]. Continued research is imperative to validate the effectiveness and long-term benefits of these interventions within the SCI patient population.

An additional consideration pertains to the impact of neuropathic pain on functional outcomes, including ambulation and independence in daily activities. In our study, no significant differences were observed in SCIM III and WSCI scores between patients with and without neuropathic pain, suggesting that neuropathic pain may not directly impair functional ability in SCI individuals. Nevertheless, it is crucial to consider that pain can indirectly affect function by diminishing motivation, reducing participation in physical activities, and negatively influencing overall quality of life [29]. Therefore, further investigations are warranted to elucidate the complex interactions among neuropathic pain, functional status, and rehabilitation outcomes in this population.

Lastly, it is important to acknowledge the limitations of our study when interpreting and comparing our findings with the existing literature. The relatively small sample size may limit the generalizability of our results to the broader population of individuals with spinal cord injury. Furthermore, the cross-sectional design inherently restricts our ability to infer causal relationships between neuropathic pain and the clinical, psychological, and functional variables examined. Future longitudinal studies with larger cohorts are warranted to provide more robust evidence and to better elucidate the temporal dynamics and potential causal pathways of neuropathic pain in patients with spinal cord injury.

5. Conclusions

In conclusion, our study corroborates existing literature regarding the high prevalence of neuropathic pain among individuals with spinal cord injury and its significant adverse effects on mental health and quality of life. Despite ongoing advancements in assessment and management strategies, there remains a critical need to explore alternative therapeutic approaches and to address the multifaceted impact of neuropathic pain on functional outcomes. Enhancing our understanding of neuropathic pain in this population is essential to developing comprehensive, patient-centered care models that ultimately improve the overall well-being and quality of life of individuals living with spinal cord injury.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org, Table S1: Mean demographic, SCIM 3, BDI, BAI and SF-36 values of the patients, Table S2: Demographic characteristics of the patients with neuropathic pain and non-painful group, Table S3: BAI and SF-36 scores of the groups, Table S4: Correlation analysis between LANSS Pain Score and clinical parameters.

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Informed Consent Statement: Written informed consent has been obtained from the patients to publish this paper,.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Conflicts of Interest: The authors declare no conflicts of interest.

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