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ORIGINAL ARTICLE

Relationship between neuropathic pain and spasticity in patients with spinal cord injury: cross-sectional clinical study

Relação entre dor neuropática e espasticidade em pacientes com trauma raquimedular: estudo clínico transversal

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ABSTRACT

BACKGROUND AND OBJECTIVES: Neuropathic pain and spasticity are common complications in patients with spinal cord injury (SCI). Although they share several characteristics, the literature has insufficient evidence to support their correlation in SCI patients. This study aimed to characterize neuropathic pain in SCI patients and investigate its correlation with spasticity.

METHODS: A cross-sectional study was conducted with 20 SCI patients treated at a rehabilitation center in Belo Horizonte, Brazil. Clinical and demographic data were collected, along with a semi-structured questionnaire to characterize pain. Pain intensity was assessed using the Numerical Rating Scale (NRS), while the frequency and severity of spasms were evaluated using the Penn Spasm Frequency Scale. Statistical analyses included the Kolmogorov-Smirnov test, Spearman correlation, and Chi-square test ($p \leq 0.05$).

RESULTS: Of the patients, 90% were male, and 79% had paraplegia. Neuropathic pain was reported in 50% of cases, with an average score of 7.2 ± 2.2. The pain primarily affected the lumbar region and was described as burning by most patients (70%). Spasms were reported by 85%, with 55% experiencing moderate to severe spasms frequently. No significant correlation was found between pain intensity and spasm frequency ($r = 0.191$; $p = 0.43$) or severity ($r = -0.239$; $p = 0.32$). Additionally, no association was observed between the presence of pain and the occurrence of spasms ($p = 0.86$).

CONCLUSION: Neuropathic pain and spasticity are common issues following SCI. However, this study did not identify a significant correlation between these conditions.

KEYWORDS: Pain, Chronic pain, Muscle Spasticity, Spinal cord injuries.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A dor neuropática e a espasticidade são complicações frequentes em pacientes com trauma raquimedular (TRM). Embora compartilhem diversas características, não há dados suficientes na literatura que sustentem sua correlação em pacientes com TRM. Este estudo teve como objetivo caracterizar a dor neuropática em pacientes com TRM e investigar sua correlação com a espasticidade.

MÉTODOS: Estudo transversal realizado com 20 pacientes com TRM, atendidos em uma unidade de reabilitação em Belo Horizonte. Foram coletados dados clínicos e demográficos, além de um questionário semiestruturado para caracterizar a dor. A intensidade da dor foi medida pela Escala Visual Numérica (EVN), enquanto a frequência e a gravidade dos espasmos foram avaliadas pela Escala de Penn. Análises estatísticas incluíram os testes de Kolmogorov-Smirnov, correlação de Spearman e Qui-quadrado ($p \leq 0,05$).

RESULTADOS: Dos pacientes, 90% eram do sexo masculino, e 79% apresentavam paraplegia. A dor neuropática foi observada em 50% dos casos, com escore médio de 7,2 ± 2,2, afetando principalmente a região lombar e descrita como queimação pela maioria (70%). Espasmos foram relatados por 85%, com 55% apresentando espasmos moderados a graves com frequência. Não foi encontrada correlação significativa entre a intensidade da dor e a frequência ($r = 0,191$; $p = 0,43$) ou gravidade ($r = -0,239$; $p = 0,32$) dos espasmos. Além disso, não foi encontrada associação entre a presença de dor e a ocorrência de espasmos ($p = 0,86$).

CONCLUSÃO: A dor neuropática e a espasticidade são problemas comuns após TRM, porém neste estudo, não houve correlação significativa entre elas.

DESCRITORES: Dor, Dor crônica, Espasticidade muscular, Traumatismo da medula espinhal.

HIGHLIGHTS

- Neuropathic pain was frequent in patients with spinal cord trauma, mostly intense and localized in the lumbar region
- Spasticity was common, often accompanied by moderate to severe spasms
- No significant relationship between pain intensity and spasms were observed

INTRODUCTION

Spinal cord trauma (SCI) is a severe condition characterized by injuries to the spinal cord, nerve roots, bone structures and disc-ligament components, resulting in partial or total interruption of communication between the brain and body locations below the level of the injury, resulting in debilitating damage to multiple motor, sensory and autonomic circuits[1-3]. It is estimated that more than 90% of cases of spinal cord injury are traumatic in origin, usually resulting from car accidents, violence, sport activities, falls and firearm injuries[4-7]. The global incidence of SCI varies between 250,000 and 500,000 cases a year[8]. In Brazil, it is estimated that there are around 10,000 new cases every year, affecting mainly men aged between 15 and 40[9]. Among the most common complications after SCI are loss of sensation and function below the level of the injury, emotional issues such as depression and anxiety, and secondary complications such as incontinence, pressure ulcers, contractures, respiratory changes, pain and spasticity[2,5].

Pain and spasticity are important conditions that often coexist in patients with SCI. Pain is a persistent and debilitating condition that affects up to 80% of individuals with SCI, one third of whom characterize it as severe, resulting in significant impacts on quality of life[10,11]. SCI patients may experience nociceptive pain, neuropathic pain or a combination of both[10,12]. Nociceptive pain, resulting from stimulation of the peripheral nerves, is the most common and easily identifiable, usually located in the shoulder, wrists and back due to overuse or muscle weakness[11,13,14].

On the other hand, neuropathic pain, defined as "pain caused by an injury or disease of the somatosensory nervous system", is more complex and challenging to characterize, although it is just as common as musculoskeletal pain[11,14]. This pain affects more than 50% of individuals with SCI and often manifests itself in the first year after the injury. It is associated with a significant decrease in quality of life, depression, mood swings and greater use of health resources[15-17].

Spasticity, which can be defined as "disordered sensory-motor control resulting from an upper motor neuron lesion, presenting as intermittent or sustained involuntary muscle activation", is present in around 70% of cases of SCI[6,18,19]. The most problematic form of spasticity, which limits function and/or requires treatment with antispastic drugs, affects around 35% of people living with chronic SCI. This condition is linked to significant functional impairments and contributes to a marked reduction in individuals' quality of life[19,20].

Pain and spasticity are two of the most challenging complications in the clinical management of patients with SCI, often coexisting and having an impact on their quality of life. Although neuropathic pain and spasticity share some neurophysiological characteristics, the relationship between the two is still little explored in the literature, which makes this study particularly relevant[6]. It is believed that the presence of pain is related to greater intensity of muscle spasm and discomfort[21-23]. The lack of data on the correlation between neuropathic pain and spasticity in patients with SCI makes the present study essential for advancing knowledge of these conditions, contributing to a deeper understanding and the development of more effective therapeutic approaches aimed at improving the quality of life of these patients. Therefore, the study aimed to explore the different domains of neuropathic pain in a group of patients with traumatic SCI and analyze their correlation with the frequency and intensity of spasms.

METHODS

A cross-sectional study carried out at a neurofunctional rehabilitation center located in the city of Belo Horizonte and approved by the institution's Research Ethics Committee (CAAE 05178818.3.0000.0022).

The sample was chosen by convenience, and the inclusion criteria were patients with SCI, adults (aged 18 or over), of both genders, seen at the rehabilitation center between May and September 2019. Participants were recruited by convenience from among the patients seen during this period and invited to take part in the study during their regular appointments. Only those who signed the Free and Informed Consent Term (FICT) were included. Patients with other neurological diseases were excluded.

The chosen patients were assessed at a single point in time. Information was collected from the medical records, including gender, age, education, work, comorbidities, neurological level and injury severity according to the International Standards for the Neurological Classification of Spinal Cord Injury, which uses the American Spinal Injury Association (AIS) Scale[24]. A semi-structured questionnaire containing information on neuropathic pain (presence or not, location and characteristics: burning, tingling, stabbing or other sensations) was used with the Numerical Rating Scale (NRS) to classify pain intensity, in which the patient evaluates the intensity of their pain from 0 to 10 (0 = no pain and 10 = extreme pain). Mild pain = 1-4, moderate pain = 5-6 and severe pain = 7-10)[21,25].

Another instrument used was the PENN Spasm Frequency Scale, with the aim of assessing the frequency and severity of muscle spasms. It is a scale that can be used to characterize an individual's spasticity and to measure the response of the treatment to the intervention. It consists of two questions: in the first, the patient rates their frequency of spasms over the last seven days on a scale of five levels, ranging from zero (no spasms) to 4 (spasms occurring more than 10 times an hour). The second question only applies to cases where the answer to the first question is different from zero. This stage of the scale assesses the severity of the spasms in three possible levels: 1 (mild), 2 (moderate) and 3 (severe)[26-28].

Statistical analysis

The data was analyzed using the SigmaStat 3.1 software. Descriptive statistics were used to characterize the sample, including measures of frequency, central tendency and variability. For inferential statistics, the normality of all the variables was checked using the Kolmogorov-Smirnov test and the Spearman's correlation test was used to check the association between variables. The Chi-square test was used to analyze the association between the presence of pain and spasms. *P*-values ≤ 0.05 were considered statistically significant.

RESULTS

Twenty individuals with SCI took part in the study, most of them male (90%), with paraplegia (79%) and a mean age of 33.5 ± 7.1 years (minimum age: 23 and maximum: 48), 40% had completed high school, 50% of the participants were employed at the time of data collection. The most frequently affected neurological level was T6 (21.1%). In addition, 79% had a complete lesion. The presence of comorbidities was observed in 10% of cases, all diagnosed with systemic arterial hypertension. Characteristics of the sample is shown in Table 1.

A total of 50% of the study patients reported neuropathic pain. The mean NRS score of these patients was 7.2 ± 2.2. The data on pain intensity is shown in Table 2.

Location and characteristics of neuropathic pain are reported in Table 3. The most affected location was the low back, and the most frequent description was of the burning sensation of pain.

Regarding spasticity, 85% of the patients complained of spasms, and 55% reported having frequent moderate to severe spasms (scores 3 and 4 on the PENN scale) (Table 4).

There was no correlation between the intensity of NRS scores and the frequency and severity of spasms (Table 5). Similarly, there was no significant association between the presence of spasms and pain (p = 0.86).

Table 1. Characteristics of individuals with spinal cord injury (n=20).

Variables	n (%)
Age (years)*	
18-29	7 (36.8%)
30-39	9 (47.4%)
40-49	3 (15.8%)
Schooling	
Elementary incomplete	1 (5%)
Elementary complete	3 (15%)
High school incomplete	3 (15%)
High school complete	8 (40%)
College incomplete	3 (15%)
College complete	2 (10%)
Work	
Yes	10 (50%)
No	10 (50%)
Neurological level*	
C4	1 (5.1%)
C6	2 (11%)
C8	1 (5.1%)
T4	1 (5.1%)
T5	1 (5.1%)
T6	4 (21.1%)
T7	1 (5.1%)
T8	3 (16.1%)
T9	3 (16.1%)
T11	1 (5.1%)
T12	1 (5.1%)
(AIS)*	
A	15 (79%)
B	3 (16%)
C	0 (0%)
D	1 (5%)
Comorbidities	
Yes (SAH)	2 (10%)
No	18 (90%)

*Data missing from one medical record; AIS: American Spine Injury Association; AIS A: Complete Spinal Cord Injury; AIS B: Incomplete, sensitivity present and motor absent; AIS C: Incomplete, sensibility present, and motor less than half of the key muscles below the neurological level have a muscular strength level ≥ 3. AIS D: Incomplete, sensibility present and motor at least half of the key muscles below the neurological level show muscle strength grade ≥ 3; SAH: systemic arterial hypertension.

DISCUSSION

The present study investigated neuropathic pain and spasticity in individuals with spinal cord injury in a sample whose characteristics were similar to those described in the literature, with a predominance of men, adults, around the third and fourth decade of life and with schooling ≥ 10 years[7,29,30]. Systemic arterial hypertension (SAH) was the only associated comorbidity found, similarly to a Finnish study that sought to explore the prevalence of comorbidities and secondary health conditions in the population with spinal cord injury, observing that SAH affected 38% of the participants[31].

Results indicated a predominance of paraplegia patients with complete AIS A lesions. A study carried out in Finland which aimed to establish the prevalence of general pain and the prevalence of pain classified as nociceptive and neuropathic identified that the rates of individuals with paraplegia were more frequent[32]. These findings are also consistent with the study[33], which showed that in Latin American thoracic injuries exceed the reported rate of cervical injuries.

The prevalence of neuropathic pain was 50%, comparable to 56.3% reported in a cross-sectional survey that compared the prevalence, intensity and level of interference of neuropathic pain and nociceptive pain in patients with chronic SCI[34]. In general, the participants of the present study classified their pain as severe, in line with the moderate to severe intensity ranges described in the literature[14,34]. The average pain intensity recorded was 7.2 in the NRS, similar to the average of 6.91 identified in individuals with SCI and neuropathic pain in the reference study[32]. These data highlight that the high prevalence and intensity of pain make this symptom one of the most significant complications associated with SCI.

Another study[14], which aimed to determine the general prevalence of pain, as well as classifying it as nociceptive and neuropathic

Table 2. Characteristics of pain intensity according to the numerical rating scale in individuals with spinal cord injury (n=20).

Numerical Rating Scale	n (%)	Classification of pain
0	10 (50%)	No pain
1 to 4	2 (10%)	Mild pain
5 to 6	1 (5%)	Moderate pain
7 to 10	7 (35%)	Severe pain

Table 3. Characteristics of neuropathic pain (n=10).

Areas of pain	n (%)
Low back	4 (40%)
Thoracic	2 (20%)
Gluteal	1 (10%)
Thoracolumbar	1 (10%)
LL and thoracic	1 (10%)
LL and lower back	1 (10%)
Pain description	
Burning	7 (70%)
Stabbing	3 (30%)

LL: lower limbs.

Table 4. Characteristics of spasms according to the PENN scale in individuals with spinal cord trauma (n=20).

PENN Scale	n (%)
Frequency of spasms	
0 - Absence of spasms	3 (15%)
1 - Mild spasms induced by stimulation	4 (20%)
2 - Complete spasms, not frequent, and occurring less than once an hour	2 (10%)
3 - Spasms occurring more than once per hour	7 (35%)
4 - Spasms occurring more than 10 times per hour	4 (20%)
Severity of spasms	
1 - Mild	6 (30%)
2 - Moderate	7 (35%)
3 - Severe	4 (20%)

PENN Scale: Penn Spasm Frequency Scale.

Table 5. Association between the study variables.

Scores	PENN Scale	R	p-value
NRS	Frequency of spasms	0.191	0.43
NRS	Severity of spasms	-0.239	0.32

NRS: Numerical Rating Scale; PENN Scale: Penn Spasm Frequency Scale; R: Spearman's correlation coefficient; p: statistical significance at $p \leq 0.05$.

in the Irish population, identified the burning sensation of pain as the main descriptor for neuropathic pain. The present study corroborated these findings, showing that 70% of participants reported this same sensation as the dominant characteristic of neuropathic pain.

The location of the pain was observed mainly in the thoracic, low back and lower limb regions. According to the reference authors[35], neuropathic pain tends to manifest mainly in the low back area and lower limbs, in contrast to nociceptive pain, which is more commonly found in the shoulder and neck. Moreover, in another study[32], the location of neuropathic pain was identified below the level of the injury in the majority of individuals (63%).

Spasticity is another frequently observed and highly disabling secondary condition following spinal cord injury. In the present study, 85% of the participants reported episodes of spasms, and 55% classified these spasms as moderate to severe in intensity. Similar data was obtained in a recent study that included 1436 participants, in which 51.7% of the individuals also reported moderate to severe spasticity problems[36]. These data highlight the high prevalence and significant impact that spasticity has on the quality of life of those affected.

In clinical practice, patients often report that increased spasms are associated with intensified pain. Research indicates a relationship between pain and spasticity, especially when they occur simultaneously[21,37,38]. A study[21] involving 537 individuals with SCI assessed pain intensity and spasm frequency using questionnaires incorporating the NRS and the PENN scale. The results revealed a prevalence of chronic pain in 73% of the participants and typical features of neuropathic pain in 44%. In addition, 71% presented spasticity. The study concluded that individuals with pain also exhibited greater spasticity and muscle stiffness compared to those without pain. However, the research did not differentiate neuropathic and nociceptive pain for this analysis.

The present study did not identify an association between the intensity of neuropathic pain and the severity or frequency of spasms. A recent study carried out in Italy[35], which included 385 people with traumatic and non-traumatic SCI, revealed that 48% had spasticity and 72% suffered from pain. Among those with spasticity, 137 also reported pain, 49.6% of whom had neuropathic pain while 50.4% had nociceptive pain. Despite these data, this study also found no correlation between the spasticity score, measured by the modified Ashworth scale, and the intensity of pain, assessed by the NRS. It was also observed that the intensity of pain in individuals with spasticity did not differ significantly from those without spasticity.

These results reinforce the comprehension that, although neuropathic pain and spasticity often occur simultaneously in patients with SCI and are multifactorial and complex consequences of maladaptive neuronal plasticity, the intensity of pain does not correlate with the frequency or severity of spasms. It is important to note that, although certain pharmacological interventions are effective in controlling both pain and spasticity, the relationship between these symptoms may be less direct than assumed[22,35]. This information can guide future research and treatment, highlighting the need for a more in-depth understanding of the interaction between neuropathic pain and spasticity in SCI conditions.

Although the present study has provided valid results on neuropathic pain and spasticity in patients with SCI, some limitations must be acknowledged. Firstly, the small sample size of only 20 patients may restrict the generalization of the results to a wider population. This is partly due to the sample restriction of individuals with traumatic injuries, excluding those with non-traumatic injuries and other neurological conditions. In addition, the cross-sectional nature of the study limits the ability to establish causal relationships and observe the evolution of conditions over time. Another relevant point is the limitation in the assessment of spasticity, which was carried out exclusively using the Penn Scale. The adoption of more comprehensive methods and other scales that consider different dimensions of spasticity and its functional impact could provide a more detailed and advanced analysis.

These limitations highlight the need for future studies with larger samples and longitudinal methodologies, allowing for a more robust analysis and a deeper understanding of the relationships between pain and spasticity. In addition, the implementation of a more comprehensive approach in future studies, with the inclusion of traumatic and non-traumatic SCI may contribute to a more holistic view of the conditions. The use of more comprehensive assessment strategies, including measurements of quality of life and functionality, may provide a more complete picture of patients' experiences. Clinical trials for testing therapeutic interventions, both pharmacological and non-pharmacological, are also needed to assess the effectiveness of these approaches in the management of neuropathic pain and spasticity.

CONCLUSION

The prevalence of neuropathic pain in the sample studied was 50%, with intense pain, most commonly located in the lumbar region and most often described as burning pain. The presence of spasms was 85%, which were mostly frequent and moderate to severe. There was no association between pain and the frequency and severity of spasms in the sample studied.

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