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Original article

Neuropathic pain in diabetic peripheral neuropathy and chronic low back pain syndrome: prevalence and characteristics

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Summary

Introduction. Neuropathic pain (NP) is presented with a variety of symptoms, including "positive" (e.g., spontaneous pain, paresthesia, dysesthesia, allodynia, hyperalgesia, tingling, burning) and "negative" (e.g., numbness and loss of sensation) features. The most common causes are diabetic peripheral neuropathy (DPN) and chronic low back pain syndrome (CLBPS). This study aimed to determine the frequency and characteristics of NP in these conditions and to evaluate the sensitivity of commonly used diagnostic questionnaires.

Methods. We examined 80 patients with DPN (40 with and 40 without NP) and 80 patients with CLBPS (40 with and 40 without NP). Assessments included electromyography (EMG), NIS-LL scoring for DPN, MRI of the lumbosacral spine for CLBPS and three NP questionnaires: Pain Detect Questionnaire (PD-Q), Leeds Assessment of Neuropathic Symptoms and Signs (LANSS), and Douleur Neuropathique 4 (DN4).

Results. In DPN, NP was associated with greater disease severity (higher NIS-LL scores), with allodynia being the most distinguishing symptom. In CLBPS, key NP characteristics varied across the three questionnaires. Tingling was common in both conditions, regardless of NP status.

Conclusion. Allodynia is the defining feature of NP in DPN. NP questionnaires demonstrated lower diagnostic accuracy for NP in CLBPS compared to DPN. DN4 demonstrated the highest sensitivity for NP detection.

Key words: neuropathic pain, diabetic peripheral neuropathy, chronic low back pain syndrome

Introduction

Neuropathic pain (NP) is defined by the International Association for the Study of Pain (IASP) as pain caused by a lesion or disease affecting the somatosensory nervous system [1]. Its prevalence in the general population is estimated to be between 7% and 10% [2]. Compared to nociceptive pain, NP is less common and often more challenging to diagnose. According to the

revised grading system proposed by Finnerup NB et al., NP can be classified as "possible," "probable," or "definite" [3]. Based on the site of the lesion, NP is further categorized into peripheral (affecting the nerve root, dorsal root ganglion, nerve plexus, or peripheral nerves) and central (involving the brain or spinal cord) [4]. Among these, peripheral NP is more prevalent and better studied.

Two of the most common causes of peripheral NP are diabetic peripheral neuropathy (DPN) and chronic low back pain syndrome (CLBPS). DPN affects approximately 50% of individuals with diabetes mellitus (DM) over their lifetime [5]. The global prevalence of DM in adults (ages 20–79) is currently 10.5%, with projections suggesting a rise to 11.3% by 2030 - International Diabetes Federation [6]. Chronic low back pain syndrome (CLBPS) is characterized by pain lasting at least 12 weeks, localized in the lower back between the inferior rib margin and gluteal region, which may or may not radiate to the legs [7]. It affects 4% to 10% of the population [8] and is a leading cause of work disability in developed countries. In patients with CLBPS, nociceptive and NP pain often coexist: 16% to 55% experience both types of pain, 5% to 15% have pure NP, and the remainder experience only nociceptive pain [9]. NP is presented with a broad spectrum of symptoms, including "positive" sensory symptoms (e.g., spontaneous pain, paresthesia, dysesthesia, allodynia, hyperalgesia, tingling, burning) and "negative" sensory symptoms (e.g., numbness and loss of sensation). In addition to clinical examination, standardized questionnaires play a crucial role in diagnosing NP.

The primary aim of this study was to determine the prevalence and characteristics of NP in patients with DPN and CLBPS, while excluding significant comorbidities to minimize confounding factors. Additionally, the study sought to evaluate the sensitivity of the applied NP diagnostic questionnaires in identifying NP.

Methods

The study was designed as a cross-sectional retrospective analysis and received approval from the Ethics Committee of the University Clinical Center of Republic of Srpska, Banja Luka, Bosnia and Herzegovina. Since it is a retrospective study, informed consent was waived by the Ethics Committee.

Over a two-year period (from January 1, 2023, to January 1, 2025), a total of 195 consecutive patients with suspected DPN as a complication of the type 2 DM were evaluated at the Electromyography (EMG) Laboratory of the Neurology Clinic, University Clinical Center of Republic of Srpska. Of these, 72 patients were diagnosed with definite DPN based on the criteria proposed by Dyck et al. [10] and definite NP according to Finnerup NB et al. [3].

These criteria are clear, but very long and complex. Potential readers can find them in references [3, 10]. During the same period and in the same laboratory, 208 consecutive patients with CLBPS were assessed. Among them, 72 patients were diagnosed with definite NP according to Finnerup NB et al. [3]. Exclusion criteria were significant neurological disease (stroke, dementia, severe dysphasia or dysarthria), major psychiatric disorder, cognitive impairment, other medical conditions (malignancy, heart failure, renal failure, liver failure, tuberculosis, limb amputation) history of alcohol abuse and use of psychotropic medications. A total of 20 patients with DPN and 14 patients with CLBPS were excluded from the study.

Neuropathic Pain Assessment

The remaining 52 patients with DPN and 58 patients with CLBPS underwent evaluation using three standardized NP diagnostic questionnaires: Pain Detect Questionnaire (PD-Q), Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) and Douleur Neuropathique

4 Questions (DN4). A positive NP diagnosis was indicated by the following cutoff scores: PD-Q: ≥19, LANSS: ≥12, DN4: ≥4 [11–13]. The experimental group included 40 patients with DPN and 40 patients with CLBPS who met the criteria for definite NP (Finnerup NB et al. [3]) and were tested positive on all three NP questionnaires. These patients had a definite NP diagnosis based on Finnerup NB et al. [3] and were tested positive for NP on all three questionnaires. The control group consisted of 40 patients with DPN and 40 patients with CLBPS who did not meet the criteria for NP according to Finnerup NB et al. [3] and were tested negative on all three NP questionnaires.

Electromyography examination (EMG) was performed by the single examiner on the Natus Nicolet EMG Machine (ZV). Motor and sensory nerves on the upper and lower extremities were examined. Muscles were examined on both sides using the needle electrode. Motor nerves (median, ulnar, peroneal and tibial), sensory nerves (median and sural) and muscles (extensor digitorum brevis, flexor hallucis brevis, tibialis anterior, gastrocnemius, vastus medialis and abductor pollicis brevis) were examined in patients with DPN. In patients with CLBPS, the same motor nerves, sensory nerves, and muscles in the lower extremities were examined as in patients with DPN. PN was defined as sensory, motor or sensorimotor according to the type of predominantly affected nerves, or according to the pathophysiological mechanism of nerve damage as axonal, demyelinating or axonal-demyelinating [14, 15].

Sociodemographic and clinical data collection

A general questionnaire was used to collect sociodemographic data for both the DPN and CLBPS groups, including: sex, current age, level of education, marital status, occupation and employment status.

Clinical characteristics - DPN group

The following parameters were assessed: age at onset and duration of DM and DPN, DM therapy, presence of comorbidities and current treatment regimen, type of polyneuropathy (PN) evaluated using electromyographic (EMG) testing, severity of PN, assessed using the NIS-LL score [16].

Clinical characteristics - CLBPS group

The following parameters were analyzed: age at onset and duration of the disease, presence of comorbidities and current treatment regimen, identification of affected nerve roots and degree of compression assessed via EMG, magnetic resonance imaging (MRI) of the lumbosacral spine, performed in all CLBPS patients.

Statistical data processing was performed in SPSS software package version 28.0. Using the Kolmogorov-Smirnov test, we first analyzed all the variables under investigation to determine whether they were normally distributed. The difference between two continuous nonparametric variables was tested using the Mann-Whitney U test, while the Student's t-test was used for continuous parametric variables. Sensitivity of the questionnaire was calculated as a percentage of subjects positive on an individual tool that were later diagnosed as a definite NP (Finnerup NB criteria + positive result on all three questionnaires). For all statistical tests, level of statistical significance was 0.05 for statistically significant difference and 0.01 for statistically highly significant difference.

Results

Among 195 patients with DPN, 36.9% met the diagnostic criteria for NP according to Finnerup NB et al. Twenty patients were excluded due to comorbidities. Of the remaining patients, 40 were tested positive on all three NP

diagnostic scales, confirming the definite NP diagnosis. The sensitivity of each questionnaire was as follows: PD-Q 76%, LANSS 80% and DN4) 91%.

Among 208 patients with CLBPS, 34.6% met the NP diagnostic criteria. Fourteen patients were excluded due to comorbid disorders. Of the remaining subjects, 40 were tested positive on all three scales, confirming definite NP. The sensitivity of the questionnaires in this group was: PD-Q 74%, LANSS 76% and DN4 90%. Among the three scales, DN4 exhibited the highest sensitivity, although none achieved perfect identification of all NP cases.

Sociodemographic and Clinical Characteristics

The sociodemographic and clinical characteristics of patients with DPN, with and without NP, are summarized in table 1. Patients in the experimental group (DPN with NP) had a significantly more severe form of DPN, as measured by the NIS-LL scores ($p < 0.01$). However, no significant differences were observed in other clinical or demographic parameters.

The sociodemographic and clinical characteristics of patients with CLBPS, with and without NP, are presented in table 2. EMG test-

Table 1. Sociodemographic and clinical characteristics of patients with diabetic peripheral neuropathy with and without neuropathic pain

Characteristics	Patients with NP (n = 40)	Patients without NP (n = 40)
Sex (% of men)	50.0	50.0
Age (years, mean ± SD)	58.5 ± 5.2	59.6 ± 5.0
Education (%)		
lower	15.0	12.5
medium	65.0	65.0
high	20.0	22.5
Occupation (%)		
physical job	40.0	40.0
intellectual work	60.0	60.0
Employment status (%)		
employed	62.5	65.0
unemployed	37.5	35.0
Marital status (%)		
lives with a partner	87.5	85.0
lives alone	12.5	15.0
Age at onset of DSPN (years, mean ± SD)	54.2 ± 7.8	52.8 ± 7.9
Disease duration (years, mean ± SD)	8.1 ± 2.4	7.8 ± 2.0
Diabetes therapy (%)		
oral	60.0	62.5
insulin	27.5	22.5
both	12.5	15.0
Type of polyneuropathy (%)		
sensory	45.0	47.5
sensorimotor	55.0	52.5
Type of polyneuropathy (%)		
axonal	70.0	67.5
axonal-demyelinating	30.0	32.5
NISS-LL total score (mean ± SD)**	12.2 ± 3.3	4.8 ± 1.6

*$p < 0.05$; **$p < 0.01$; SD - standard deviation; DPN - diabetic peripheral neuropathy; NP - neuropathic pain

ing revealed that patients with CLBPS and NP had at least one affected nerve root and more severe nerve root compression. All patients with NP had disc herniation, significantly less degenerative changes, and the opposite result was obtained in the control group ($p < 0.05$).

Table 2. Sociodemographic and clinical characteristics of patients with chronic low back pain syndrome with and without neuropathic pain

Characteristics	Patients with NP (n = 40)	Patients without NP (n = 40)
Sex (% of men)	52.5	52.5
Age (years, mean ± SD)	51.2 ± 6.1	50.5 ± 5.8
Education (%)		
lower	15.0	17.5
medium	67.5	70.0
high	17.5	12.5
Occupation (%)		
physical job	42.5	42.5
intellectual work	57.5	57.5
Employment status (%)		
employed	75.0	72.5
unemployed	25.0	27.5
Marital status (%)		
lives with a partner	87.5	85.0
lives alone	12.5	15.0
Age at CLBPS onset (years, mean ± SD)	47.5 ± 7.2	47.4 ± 7.0
Disease duration (years, mean ± SD)	4.6	4.4
CLBP (% of patients)		
unilateral	65.0	67.5
bilateral	35.0	32.5
Root involve according to EMG (% of patients)*		
none	0.0	20.0
L3	10.0	5.0
L4	22.5	5.0
L5	35.0	35.0
S1	32.5	35.0
Severity of radiculopathy according to EMG (% of patients)**		
absent	0.0	25.0
mild	30.0	65.0
moderate	42.5	10.0
severe	27.5	0.0
Type of the lesion according to MRI (% of patients)*		
disc herniation	100.0	15.0
degenerative changes	35.0	90.0

*$p < 0.05$; **$p < 0.01$; SD - standard deviation; CLBPS - chronic low back pain syndrome; EMG - electromyography; MRI - magnetic resonance imaging; NP - neuropathic pain

Pain characteristics in DPN and CLBPS patients

The frequency of different pain features in patients with DPN, with and without NP, is shown in table 3. All NP characteristics were significantly more frequent in patients with NP.

Allodynia was the most significant indicator of NP across all three questionnaires ($p < 0.01$). Tingling was a common symptom in both DPN groups, but it often occurred as an isolated symptom in DPN patients without NP.

The frequency of different pain features in patients with CLBPS, with and without NP, is summarized in table 4. As with DPN, all NP characteristics were significantly more common in CLBPS patients with NP. The most significant NP feature in each questionnaire was: PD-Q: electric shock-like pain, LANSS:

Table 3. Frequency of different pain features in patients with diabetic peripheral neuropathy with and without neuropathic pain

	Patients with NP (n = 40)	Patients without NP (n = 40)
PD-Q		
Burning**	90.0	20.0
Tingling or pricking**	97.5	85.0
Light touching painful**	85.0	15.0
Electric shocks**	62.5	12.5
Cold or heat painful**	75.0	17.5
Numbness**	97.5	72.5
Slight pressure painful**	85.0	12.5
LANSS		
Pricking, tingling, pins and needles**	97.5	75.0
Skin in the painful area looks different**	17.5	0
Abnormally sensitive to touch**	85.0	15.0
Electric shocks, jumping and bursting**	62.5	7.5
Hot and burning**	95.0	35.0
Allodynia**	85.0	12.5
Altered pin-prick threshold**	87.5	37.5
DN4		
Burning**	95.0	25.0
Painful cold**	75.0	20.5
Electric shocks**	62.5	10.0
Tingling**	97.5	72.5
Pins and needles**	97.5	22.5
Numbness**	90.0	50.0
Itching**	37.5	2.5
Hypoesthesia to touch**	97.5	50.0
Hypoesthesia to pinprick**	87.5	12.5
Allodynia**	85.0	12.5

NP - neuropathic pain; Pain Detect Questionnaire - PD-Q; Leeds Assessment of Neuropathic Symptoms and Signs - LANSS; Douleur Neuropathique 4 questions - DN4

altered pin-prick threshold and DN4: hypoesthesia to touch.

Diagnostic Sensitivity of NP questionnaires The sensitivity of the PD-Q, LANSS, and DN4 questionnaires in diagnosing NP in patients with DPN and NP and CLBPS and NP is presented in table 5.

Table 4. Frequency of different pain features in patients with chronic low back pain syndrome with and without neuropathic pain

	Patients with NP (n = 40)	Patients without NP (n = 40)
PD-Q		
Burning**	95.0	62.5
Tingling or pricking**	85.0	70.0
Light touching painful**	56.0	40.0
Electric shocks**	90.0	12.5
Cold or heat painful**	40.0	35.0
Numbness**	77.5	62.5
Slight pressure painful**	60.0	45.0
LANSS		
Pricking, tingling, pins and needles**	95.0	77.5
Skin in the painful area looks different**	5.0	0
Abnormally sensitive to touch**	72.5	25.0
Electric shocks, jumping and bursting**	85.0	32.5
Hot and burning**	97.5	37.5
Allodynia**	85.0	25.0
Altered pin-prick threshold**	90.0	15.0
DN4		
Burning**	90.0	12.5
Painful cold**	35.0	12.5
Electric shocks**	87.5	15.0
Tingling**	90.0	80.0
Pins and needles**	90.0	35.0
Numbness**	92.5	52.5
Itching**	15.0	2.5
Hypoesthesia to touch**	92.5	7.5
Hypoesthesia to pinprick**	92.5	15.0
Allodynia**	85.0	25.0

NP - neuropathic pain; Pain Detect Questionnaire - PD-Q; Leeds Assessment of Neuropathic Symptoms and Signs - LANSS; Douleur Neuropathique 4 questions - DN4

Table 5. The sensitivity of the PD-Q, LANSS, and DN4 questionnaires in diagnosing NP in patients with DPN and CLBPS and clinical diagnosis of NP

Questionnaire	DPN	CLBPS
PD-Q	0.76	0.74
LANSS	0.80	0.76
DN4	0.91	0.90

Pain Detect Questionnaire - PD-Q; Leeds Assessment of Neuropathic Symptoms and Signs - LANSS; Douleur Neuropathique 4 questions - DN4; NP - neuropathic pain; DPN - diabetic peripheral neuropathy; CLBPS - chronic low back pain syndrome

Discussion

In our study, the prevalence of NP was 36.9% in patients with DPN and 34.6% in patients with CLBPS. These findings are consistent with most previous studies [17, 18]. Reported NP prevalence in DPN (20–50%) and CLBPS (16–55%) varies widely in the literature, likely due to methodological differences, including variations in NP definitions and pain assessment tools [17, 18].

Sociodemographic and clinical factors

Among the sociodemographic and clinical parameters analyzed in DPN patients, the only significant difference observed was disease severity - patients with NP had significantly more severe DPN, as measured by the NIS-LL scale ($p < 0.01$). While some studies suggest that older age, longer diabetes duration, and female sex increase DPN risk, others have found no significant association with these factors [19, 20]. In CLBPS patients, no significant sociodemographic differences were found between those with and without NP, which aligns with previous studies [21]. However, clinical differences were evident - patients with NP had at least one affected nerve root ($p < 0.01$) and more severe nerve root injury ($p < 0.01$) on EMG examination. Additionally, all NP patients had disc herniation and significantly fewer degenerative changes than the control group ($p < 0.05$). Conversely, degenerative changes were more common in the control group.

Neuropathic pain characteristics and questionnaire comparisons

Although certain NP characteristics were common across all three questionnaires, significant differences emerged between them, emphasizing the value of using multiple NP assessment tools. In DPN patients, allodynia was the most distinguishing feature of NP across all three questionnaires. In CLBPS patients, however, the most significant NP feature varied by questionnaire: PD-Q - electric shock-like pain, LANSS - altered pin-prick threshold and DN4 -hypoesthesia to touch. Tingling was frequent in both experimental and control groups. Interestingly, the DN4 questionnaire treats tingling as an independent item, whereas PD-Q and LANSS combine tingling with other sensations (e.g., pricking, pins, and needles). This suggests that simpler, more specific questionnaire items may improve diagnostic clarity. Patients filling out combined-item might struggle to determine which symptom best describes their experience, potentially leading to unclear or less informative responses.

Comparison with previous studies

Currently, no published studies have examined NP characteristics in homogenous groups of DPN or CLBPS patients. However, a similar study by Ünlütürk et al. (2022) assessed PD-Q, LANSS, and DN4 in 102 DPN patients with

NP and the control group of 101 patients with non-neuropathic pain (non-NP). Their findings closely align with ours, showing allodynia (as in our study) and hyperalgesia as key NP features [22]. This emphasizes the value of questionnaires incorporating both patient-reported symptoms and physician assessments. Unlike PD-Q, which relies solely on patient self-reporting, LANSS and DN4 include physician-administered clinical tests, making them more comprehensive [11–13]. Other studies have applied PD-Q, LANSS, and DN4 simultaneously in mixed groups of NP patients (including radiculopathies, postherpetic neuralgia, trigeminal neuralgia, DPN, and CLBPS) [23–25]. However, these studies did not focus on homogeneous experimental and control groups, making direct comparisons challenging.

Sensitivity of NP questionnaires

In our study, DN4 had the highest sensitivity for NP diagnosis: DPN group 91% and CLBPS group 90%. LANSS showed moderate sensitivity, while PD-Q had the lowest sensitivity for diagnosing NP in both conditions. These findings align with the recommendations of the European Academy of Neurology (EAN), the European Pain Federation (EFIC), and the Neuropathic Pain Special Interest Group (NeuPSIG) of the International Association for the Study of Pain [26].

Strengths and implications of this study

A key strength of our study is its homogeneous experimental and control groups, allowing for a more precise evaluation of NP characteristics and diagnostic questionnaire performance. In contrast, previous studies often assessed NP in heterogeneous patient populations, limiting direct applicability to specific conditions.

These findings reinforce the importance of selecting appropriate NP diagnostic tools and highlight DN4 as the most sensitive questionnaire for both DPN and CLBPS. Future research should further explore NP characteristics across different patient populations and refine standardized assessment methods for improved clinical accuracy.

Conclusion

Our findings highlight allodynia as the most significant NP characteristic in DPN, whereas NP features in CLBPS varied across diagnostic questionnaires. DN4 demonstrated the highest sensitivity, particularly in DPN, supporting its role as a preferred NP screening tool.

Unlike PD-Q, DN4 includes a physician-administered component, enhancing its diagnostic accuracy. Due to its high sensitivity and comprehensive approach, DN4 could be recommended as a routine tool in diagnosing NP in clinical practice, especially in patients with DPN, as well as in cases where NP is associated with radiculopathy.

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Ethical approval. The Ethics Committee of the University Clinical Center of Republic of Srpska, Banja Luka, Republic of Srpska, Bosnia and Herzegovina, approved the study (No. 01-19-55-2/25; 12.02.2025) and informed consent was obtained from all individual respondents. The research was conducted according to the Declaration of Helsinki.

Conflicts of interest. The authors declare no conflict of interest.

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Neuropatska bol kod dijabetične periferne neuropatije i hroničnog bola u donjem dijelu leđa: učestalost i karakteristike

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Uvod. Neuropatski bol (NP) karakteriše se različitim simptomima, uključujući "pozitivne" simptome (npr. spontani bol, parestezija, disestezija, alodinija, hiperalgezija, trnjenje, peckanje) i "negativne" simptome (npr. utrnulost, gubitak senzacije). Najčešći uzroci NP-a su dijabetska periferna neuropatija (DPN) i sindrom hroničnog bola u donjem dijelu leđa (CLBPS). Cilj ovog istraživanja bio je da se utvrdi učestalost i karakteristike NP u ovim stanjima i da se procijeni osjetljivost najčešće korišćenih dijagnostičkih upitnika.

Metode. Ispitano je 80 pacijenata sa DPN (40 sa NP i 40 bez NP) i 80 pacijenata sa CLBPS (40 sa NP i 40 bez NP). Procjene su uključivale elektromiografiju (EMG), NIS-LL skor za DPN, MRI lumbosakralne kičme za CLBPS i tri NP upitnika: Pain Detect Questionnaire (PD-Q), Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) i Douleur Neuropathique 4 (DN4).

Rezultati. Kod DPN, NP je bio povezan sa težom bolešću (viši NIS-LL skorovi), pri čemu je alodinija bila najistaknutiji simptom. Kod CLBPS, ključne karakteristike NP varirale su među tri upitnika. Trnjenje je bilo čest simptom u oba stanja, bez obzira na status NP.

Zaključak. Alodinija je karakteristična osobina NP kod DPN. NP upitnici su pokazali nižu dijagnostičku tačnost za NP u CLBPS u poređenju sa DPN. DN4 je pokazao najveću osjetljivost u otkrivanju NP, što sugeriše da je najkorisniji alat za dijagnostiku NP, posebno u slučajevima CLBPS.

Ključne riječi: neuropatski bol, dijabetska periferna neuropatija, sindrom hroničnog bola u donjem dijelu leđa