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Research

The Neuropathic Dimension of Shoulder Pain: The Effects of Neuropathic Pain on Shoulder Function and Functional Limitation

Omuz Ağrısının Nöropatik Boyutu: Nöropatik Ağrının Omuz Fonksiyonu ve Fonksiyonel Kısıtlılık Üzerine Etkileri

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ABSTRACT

Objective: To determine the effects of neuropathic pain on pain intensity and shoulder function in patients with chronic shoulder pain.

Methods: A total of 102 patients experiencing chronic shoulder pain were enrolled in this cross-sectional observational study. Neuropathic pain was assessed using the Douleur Neuropathique 4 (DN4) questionnaire. Patients were grouped according to DN4 cut-off scores into a neuropathic pain group (≥4) and a non-neuropathic pain group (<4). The visual analogue scale (VAS) and the shoulder pain and disability index (SPADI) were used to measure pain intensity and functional status, respectively.

Results: No significant differences were observed between the groups with respect to demographic characteristics (p>0.05). The incidence of pain on the dominant side was significantly lower in the neuropathic pain group (p=0.022). The neuropathic pain group had significantly higher VAS and total SPADI scores (p≤0.001). The SPADI pain and disability subscores were also significantly higher in the neuropathic group (p=0.001 and p=0.002; respectively). DN4 scores correlated positively with VAS (r=0.383; p<0.001), SPADI pain subscores (r=0.393; p<0.001), SPADI disability subscores (r=0.333; p=0.001), and total SPADI scores (r=0.359; p<0.001).

Conclusion: The presence of a neuropathic component in patients with chronic shoulder pain is associated with greater pain intensity and increased functional limitation. These findings suggest that neuropathic pain should be systematically assessed in this population.

Keywords: Shoulder pain, neuropathic pain, pain intensity, visual analogue pain scale

ÖZ

Amaç: Bu çalışmanın amacı kronik omuz ağrısı olan hastalarda nöropatik ağrının ağrı şiddeti ve omuzun fonksiyonel durumu üzerine etkilerini belirlemektir.

Gereç ve Yöntem: Bu kesitsel gözlemsel çalışmaya kronik omuz ağrısı olan 102 hasta dahil edilmiştir. Nöropatik ağrı, Douleur Neuropathique 4 (DN4) anketi kullanılarak değerlendirilmiştir. Hastalar DN4 kesme puanlarına göre nöropatik ağrı grubu (≥4) ve nöropatik olmayan ağrı grubu (<4) olarak gruplandırılmıştır. Ağrı şiddeti vizüel analog skala (VAS) ile ölçülmüştür ve fonksiyonel durum omuz ağrısı ve sakatlık indeksi (SPADI) ile değerlendirilmiştir.

Bulgular: Gruplar arasında demografik özellikler açısından anlamlı bir fark bulunmamıştır (p>0,05). Nöropatik ağrı grubunda dominant tarafta ağrı görülme sıklığı istatistiksel olarak anlamlı derecede düşük bulunmuştur (p=0,022). Nöropatik ağrı grubunda VAS skorları ve toplam SPADI skorları anlamlı derecede daha yüksekti (p≤0,001). SPADI ağrı ve sakatlık alt skorları da nöropatik grupta anlamlı derecede yüksekti (sırasıyla p=0,001 ve p=0,002). DN4 skorları VAS (r=0,383; p<0,001), SPADI ağrı alt skorları (r=0,393; p<0,001), SPADI sakatlık alt skorları (r=0,333; p=0,001) ve toplam SPADI skorları (r=0,359; p<0,001) ile pozitif korelasyon gösterdi.

Sonuç: Kronik omuz ağrısı olan hastalarda nöropatik bir bileşenin varlığı, daha şiddetli ağrı yoğunluğu ve fonksiyonel kısıtlılıkla ilişkilidir. Bu bulgular doğrultusunda, bu popülasyonda nöropatik ağrı değerlendirmesinin sistematik olarak yapılması önerilmektedir.

Anahtar Kelimeler: Omuz ağrısı, nöropatik ağrı, ağrı şiddeti, vizüel analog ağrı skalası

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INTRODUCTION

The shoulder joint, which has the widest range of motion in the human body, is prone to traumatic and non-traumatic injuries, making shoulder pain one of the most common musculoskeletal problems in the general population (1). The lifetime prevalence ranges from 0.67% to 55.2% and differs by age group (1). Shoulder pain is a condition in which various pathologies that play a role in its etiopathogenesis, such as subacromial impingement syndrome, adhesive capsulitis, rotator cuff injuries, glenohumeral osteoarthritis, and tendinopathies, often interact to produce complex clinical presentations that complicate the diagnostic process (2).

The traditional approach has attributed musculoskeletal pain mainly to nociceptive mechanisms and has organized treatment strategies accordingly (3). Recent evidence has revealed that shoulder pain is not just a nociceptive issue resulting from local tissue damage, but a complex condition that can also involve central sensitization and neuropathic mechanisms that aggravate the clinical picture and delay recovery in a significant proportion of patients (4,5). Neuropathic pain is a significant contributor to treatment resistance in shoulder pain due to maladaptive changes in the central nervous system (6). This suggests that central modulation disorders contribute to the failure of peripherally focused interventions (7).

Neuropathic pain is pain caused by a disease or lesion affecting the central or peripheral nervous system; it typically manifests with symptoms such as burning, stinging, and tingling and is usually severe (8). Shoulder pain accompanied by a neuropathic component is associated with adverse clinical outcomes, including increased pain intensity, unresponsiveness to conventional treatments, functional limitations, and a significant decrease in quality of life (9).

Despite its clinical importance, studies investigating the prevalence of neuropathic pain among patients with chronic shoulder pain and the impact of neuropathic pain on clinical outcomes are limited. This lack of information hinders the optimization of both diagnostic and treatment strategies (10,11). Therefore, systematically investigating the presence of a neuropathic component in shoulder pain is critical for developing more effective and personalized treatment approaches for this patient population.

This study aims to determine the effects of neuropathic pain on intensity of pain and functional status of shoulder in patients with chronic shoulder pain.

METHODS

Study Design

This study was designed as a descriptive, cross-sectional observational study. The study was conducted at the physical medicine and rehabilitation outpatient clinic between February 15, 2025 and April 15, 2025. Ethics committee approval was received from the University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital Scientific Research Ethics Committee (approval no: 2025-18, date: 06.02.2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, and all participants provided written informed consent before participating.

Participants

Of 126 patients assessed for eligibility, 102 were included in the study. A detailed analysis of the patient selection process and exclusion criteria is shown in the Figure 1. Participants were eligible if they were between 18 and 70 years old, had experienced shoulder pain for at least three months, and agreed to participate in the study voluntarily. Exclusion criteria included having a history of trauma or surgery to the affected shoulder; having received injections or physical therapy for the affected shoulder within the past six months; or having a diagnosed psychiatric disorder, such as severe depression, anxiety disorder, or psychosis. Additional exclusion criteria included central nervous system disorders (e.g., Parkinson's disease or multiple sclerosis), diabetes mellitus, pregnancy, severe cognitive impairment that could hinder cooperation or the ability to complete study-related questionnaires, and chronic decompensated cardiac, renal, or hepatic failure.

Data Collection and Assessments

Data for all participants were recorded, including demographic details (age, gender, level of education, occupation, marital status), anthropometric measurements [height, weight, body mass index (BMI)], and clinical information (symptom duration in months, dominant extremity, affected shoulder). Patient assessments were conducted using the Douleur Neuropathique 4 (DN4) to identify neuropathic pain, the visual analogue scale (VAS) to assess pain intensity, and the shoulder pain and disability index (SPADI) to measure shoulder-related functional limitations.

Douleur Neuropathique 4

The DN4 questionnaire consists of 10 items based on patient interviews and clinical examinations, with a total

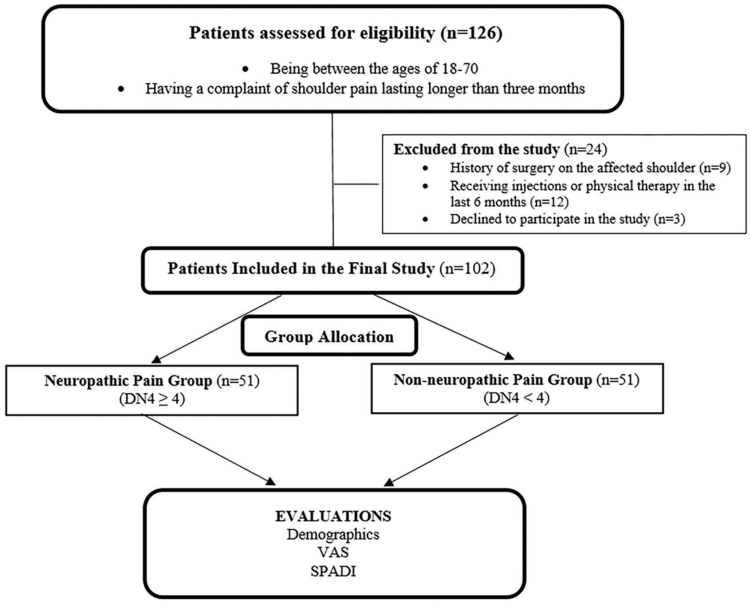

Figure 1. Flow chart of the study
Of the 126 patients assessed for eligibility, 102 were included in the final study after excluding 24 who did not meet the inclusion criteria or declined to participate. Participants were allocated into two groups based on their Douleur Neuropathique 4 (DN4) questionnaire scores: the neuropathic pain group (DN4≥4; n=51) and the non-neuropathic pain group (DN4<4; n=51)
VAS: Visual analogue scale, SPADI: Shoulder pain and disability index

score ranging from 0 to 10. Scores of 4 or higher indicate neuropathic pain (12). Participants were categorized into two groups based on their DN4 scores: a neuropathic pain group (DN4≥4) and a non-neuropathic pain group (DN4<4).

Visual Analogue Scale

VAS is a 10 centimeter scale used to assess pain, with one end representing "no pain" and the other end indicating "worst possible pain" Participants were asked to indicate their pain on a scale from 0 (no pain) to 10 (worst possible pain).

Shoulder Pain and Disability Index

The SPADI is a valid and reliable instrument in Turkish, as reported by Bumin et al. (13). It consists of two subscales: pain (five items) and disability (eight items). All subscale scores and the total score are standardized and expressed on a 0-100 scale. Total scores range from 0 to 100; higher scores indicate greater pain and functional limitation in the affected shoulder (13).

Sample Size

The sample size was calculated using G*Power software (version 3.1.9.4; Franz Faul, Universität Kiel, Germany). The analysis assumed a t-test for between-group comparisons with a statistical power of 80%, a significance level of 5% (α=0.05), and a medium effect size (d=0.5). Based on these parameters, the required sample size was calculated as 102 participants in total (51 participants per group).

Statistical Analysis

The normality of the distribution of continuous variables was assessed using the Kolmogorov-Smirnov test with Lilliefors correction. Continuous variables were summarized as mean±standard deviation and range (minimum-maximum). Categorical variables were presented as frequencies and percentages. Comparisons between two independent groups were made using the Mann-Whitney U test for non-normally distributed data and the independent samples t-test for normally distributed data. The homogeneity of categorical variables across groups was assessed using Pearson's chi-square test. Spearman's rank correlation coefficient was used to evaluate the relationships between variables because the data did not meet the normality assumption. Statistical significance was defined as $p<0.05$. Data analyses were performed using IBM SPSS Statistics version 21.0.

RESULTS

Tables 1 and 2 summarize the demographic and clinical characteristics of the 102 patients enrolled in the study. Among the participants, 70.6% were female, and the right shoulder was the most commonly affected side (57.8%). No statistically significant differences were observed between groups in terms of demographic variables, including age, BMI, pain duration, gender, and education level ($p>0.05$).

The neuropathic pain group had significantly higher VAS pain intensity and total SPADI scores than the non-neuropathic pain group (p≤0.001). Additionally, the SPADI pain and disability subscores were significantly higher in the neuropathic pain group (p=0.001 and p=0.002; respectively) (Table 1). The incidence of pain on the dominant side was found to be significantly lower in the neuropathic pain group (p=0.022) (Table 2).

No statistically significant correlations were found between DN4 scores and age, height, weight, duration of pain, or BMI (p>0.05). However, DN4 scores were positively correlated with VAS pain intensity [r=0.383; p<0.001; 95% confidence interval (CI) (0.214, 0.533)], the SPADI pain subscore [r=0.393; p<0.001; 95% CI (0.211, 0.554)], the SPADI disability subscore [r=0.333; p=0.001; 95% CI (0.138, 0.511)], and the total SPADI score [r=0.359; p<0.001, 95% CI (0.162, 0.540)] (Table 3).

Table 1. Comparison of demographic and clinical characteristics of the groups

	Neuropathic pain group (n=51)		Non-neuropathic pain group (n=51)		p-value
	Mean±SD	Min-max	Mean±SD	Min-max	
Age (years)	52.16±11.45	24-74	54.33±11.74	24-81	0.418**
Height (cm)	165.41±10.50	150-188	161.49±6.57	144-185	0.636**
Weight (kg)	76.22±17.33	49-128	71.37±12.70	49-95	0.111*
BMI (kg/m²)	27.81±5.53	19.10-40.89	26.58±4.70	19.92-37.58	0.235**
Duration of pain (months)	10.61±7.94	3-36	10.27±8.57	3-36	0.535**
VAS	8.08±1.51	4-10	6.84±1.79	3-10	**<0.001****
SPADI pain subscores	80.78±14.63	44-100	68.04±20.43	0-100	**0.001****
SPADI disability subscores	67.92±20.16	5-98.80	54.97±20.71	7.5-87.50	**0.002****
Total SPADI score	72.85±16.52	33.90-97.70	59.93±19.58	11.50-89.20	**<0.001***

*: Independent samples t-test, **: Mann-Whitney U test, SD: Standard deviation, BMI: Body mass index, SPADI: Shoulder pain and disability index, VAS: Visual analogue scale

Table 2. Distribution and comparison of categorical demographic characteristics of the groups

		Neuropathic pain group (n=51) n (%)	Non-neuropathic pain group (n=51) n (%)	p-value
Affected side	Right	25 (49%)	34 (66.7%)	0.71
	Left	26 (51%)	17 (33.3%)	
Dominan side	Right	48 (94.1%)	46 (90.2%)	0.461
	Left	3 (5.9%)	5 (9.8%)	
Dominant side affected	Yes	28 (54.9%)	39 (76.5%)	**0.022**
	No	23 (45.1%)	12 (23.5%)	
Education level	Primary school	23 (45.1%)	22 (43.1%)	0.844
	Middle school	7 (13.7%)	6 (11.8%)	
	High school	16 (31.4%)	15 (29.4%)	
	University	5 (9.8%)	8 (15.7%)	
Marital status	Married	40 (78.4%)	40 (78.4%)	1.000
	Single	11 (21.6%)	11 (21.6%)	
Gender	Male	13 (25.5%)	17 (33.3%)	0.385
	Female	38 (74.5%)	34 (66.7%)	
Employment status	Employed	37 (72.5%)	33 (64.7%)	0.393
	Unemployed	14 (27.5%)	18 (35.3%)	

Pearson chi-square

Table 3. Correlation between DN4 scores and other parameters

	DN4 Scores		
	r	**p-value**	**95% confidence interval**
Age (years)	-0.087	0.386	-0.302, 0.124
Height (cm)	-0.023	0.819	-0.214, -0.172
Weight (kg)	0.072	0.469	-0.128, 0.258
BMI (kg/m²)	0.110	0.271	-0.098, 0.314
Duration of pain (months)	0.087	0.384	-0.103, 0.265
VAS	0.383	<0.001	0.214, 0.533
SPADI pain subscores	0.393	<0.001	0.211, 0.554
SPADI disability subscores	0.333	0.001	0.138, 0.511
Total SPADI score	0.359	<0.001	0.162, 0.540

r: Spearman correlation coefficient, DN4: Douleur Neuropathique 4, BMI: Body mass index, SPADI: Shoulder pain and disability index, VAS: Visual analogue scale

DISCUSSION

This study demonstrates that neuropathic mechanisms in patients with chronic shoulder pain are strongly associated with higher pain intensity and significantly poorer functional capacity. The findings suggest that the pathophysiology of chronic shoulder pain is not limited to nociceptive mechanisms; neuropathic processes also play a critical role. These results highlight the prognostic importance of neuropathic mechanisms in the assessment and management of shoulder pain and are consistent with current literature (14,15).

Although our study was not designed to assess prevalence, neuropathic pain was detected in half of the patients using the DN4 scale. This rate approaches the upper end of the reported prevalence range for neuropathic pain (20-55%) (5,14,16). Several demographic and methodological factors may account for this finding. First, our study included a broader age range compared with earlier reports, which typically focused on younger or surgically selected populations. The inclusion of older individuals may have increased the likelihood of age-related changes in nociceptive and neuropathic processing. Second, only patients with chronic shoulder pain (≥3 months) were enrolled, resulting in a sample enriched with persistent pain mechanisms and potential central sensitization. Third, the proportion of female participants in our cohort was higher, and previous studies have shown that women tend to report neuropathic pain symptoms more frequently due to both biological and psychosocial influences (15,16). Moreover, the application of strict exclusion criteria—such as the omission of patients with diabetes or neurological disorders—yielded a homogeneous sample in which neuropathic symptoms were more directly attributable to shoulder pathology. Finally, the use of the DN4, a sensitive screening questionnaire, as the sole assessment tool may have contributed to the higher detection rate compared with studies that employed additional confirmatory methods. Collectively, these methodological and demographic differences likely account for the higher prevalence of neuropathic pain observed in our study.

In this study, VAS scores were also found to be significantly higher in the neuropathic pain group. This can be explained by several mechanisms. Neuropathic pain is characterized by structural and functional alterations in the peripheral and central nervous systems, including abnormal neurotransmission and ectopic discharges, which contribute to heightened pain perception (17). In addition, the presence of hyperalgesia and allodynia, which are important components of neuropathic pain, may contribute to an increased perception of pain intensity (18). Another possible mechanism is central sensitization, which refers to increased sensitivity of central pain-related structures. Although our study did not directly investigate central sensitization, previous studies have reported that central sensitization and neuropathic pain often coexist (19). Moreover, reduced responsiveness to treatment has been reported in several studies, both because of the inherent characteristics of neuropathic pain and because of the coexistence of central sensitization (20). Sanchis et al. (14) reported that central sensitization significantly increases pain intensity and negatively affects treatment response. Bucak et al. (21) reported elevated somatic amplification levels in patients with shoulder impingement syndrome who did not respond to subacromial injection therapy. Similarly, Gwilym et al. (9) demonstrated that neuropathic pain in patients with shoulder impingement syndrome results in delayed postoperative recovery and persistently high pain levels. The lack of a favorable treatment response

promotes pain chronification and increases its perceived intensity at the central level. It also predisposes patients to catastrophize their pain, which further contributes to higher reported pain levels (22). In this context, the results of our study are consistent with the existing literature.

In terms of functional outcomes, the significantly higher SPADI scores across all subdimensions in the neuropathic pain group suggest that these patients experience substantial limitations in their daily lives. Previous studies have reported a strong association between increased symptoms of central sensitization and functional limitations (5,23). Nijs et al. (4) demonstrated that central sensitization exacerbates functional impairment and negatively influences treatment outcomes. Taken together, these findings imply that neuropathic mechanisms and sensory amplification may have a shared pathophysiological basis that impedes functional recovery in patients with shoulder pain.

In the shoulder pathology literature, the dominant side is more frequently affected, owing to increased mechanical loading, repetitive movements, and greater functional use (24). However, the presence of neuropathic pain appears to disrupt this typical pattern of predominant involvement of the dominant side (25). In our study, the prevalence of dominant-side involvement in individuals with neuropathic pain was significantly lower. This finding may reflect central mechanisms overriding peripheral load-related influences. Chronic nociceptive input from the shoulder can induce cortical reorganization and altered interhemispheric connectivity, leading to bilateral pain perception or a shift of pain representation independent of mechanical dominance (26). Moreover, neuroplastic changes in the somatosensory cortex and thalamus have been shown to cause pain perception to spread beyond the initially affected region, supporting the concept of central sensitization (4,7,27). These findings are consistent with the bilateral cortical reorganization processes described by Flor (26), which explain why pain localization in chronic neuropathic conditions may be determined more by central nervous system alterations than by peripheral mechanical factors. In this context, the reduced dominant-side involvement observed in our study provides important insights into the transition from peripherally driven nociceptive pain to centrally mediated neuropathic mechanisms in chronic shoulder pain.

Additionally, the lack of a significant correlation between DN4 scores and age or BMI indicates that neuropathic pain may influence the clinical course independently of these demographic factors. As conventional approaches primarily target nociceptive mechanisms, they may be ineffective in the treatment of neuropathic pain. Gabapentinoids and serotonin-norepinephrine reuptake inhibitors are recommended as first-line pharmacological agents for the management of neuropathic pain (28). However, integrating exercise protocols that address central sensitization alongside multimodal treatment strategies is essential to achieve optimal therapeutic outcomes (29). These findings reinforce the understanding that neuropathic pain is a distinct pathophysiological mechanism with significant implications for functional capacity, highlighting the need for comprehensive, individualized treatment planning.

The strengths of this study include an adequate sample size determined by power analysis, the use of validated measurement tools (DN4, VAS, and SPADI), and homogeneous inclusion criteria. These methodological features enhance the reliability and internal validity of the findings.

Study Limitations

This study has several limitations that should be acknowledged. First, its cross-sectional design limits the ability to draw causal inferences. Second, as a single-center study, the findings may have limited generalizability to broader populations. Third, neuropathic pain was evaluated solely using the DN4 questionnaire. Although DN4 is a validated and widely used screening tool, it primarily relies on subjective reports and a brief clinical examination, which may limit its sensitivity in detecting subtle neuropathic features. Additional confirmatory methods, such as quantitative sensory testing or neurophysiological assessments, could have provided a more comprehensive evaluation; however, these methods were not feasible in our outpatient clinical setting due to practical and resource-related constraints. Lastly, psychosocial variables were not included in the analysis; their omission may have influenced pain perception and functional outcomes.

CONCLUSION

In conclusion, this study highlights that the presence of a neuropathic component in patients with chronic shoulder pain is associated with greater pain intensity and increased functional limitations. These findings suggest that neuropathic pain should be systematically assessed in this population. Future research should focus on validating multimodal treatment approaches that incorporate evidence-based strategies for neuropathic pain, such as specific pharmacological agents and exercise protocols addressing central sensitization, within this patient group.

ETHICS

Ethics Committee Approval: Ethics committee approval was received from the University of Health Sciences Türkiye, İstanbul Physical Therapy and Rehabilitation Training and Research Hospital Scientific Research Ethics Committee (approval no: 2025-18, date: 06.02.2025).

Informed Consent: All participants provided written informed consent before participating.

FOOTNOTES

Authorship Contributions

Concept: E.K., N.K., B.Ş.A., Ö.F.B., Design: E.K., N.K., B.Ş.A., Ö.F.B., Data Collection or Processing: E.K., Analysis or Interpretation: E.K., N.K., Literature Search: E.K., B.Ş.A., Ö.F.B., Writing: E.K., B.Ş.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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