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Original Article

A neuropathic pain scale is effective in identifying neuropathic pain

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Abstract: Objective: To explore the application value of a Neuropathic Pain Questionnaire (NPQ) in screening for neuropathic pain (NP). Methods: Using a prospective study approach, patients with chronic pain treated and hospitalized in Quanzhou First Hospital between September 2020 and December 2023 were chosen as study subjects. Participants were screened using NPQ and then divided into a neuropathic pain group (NP group) and a non-neuropathic pain group (NNP group) based on NPQ's results. The baseline demographic data and disease causes were evaluated using Cronbach's alpha coefficient and Guttman split-half coefficient to assess internal consistency. A receiver operating characteristic (ROC) curve was plotted, and the area under curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were assessed. Results: A total of of 121 patients were included, with 61 cases in the NP group and 60 cases in NNP group. There were no substantial differences between the NP group and the NNP group in terms of age, gender, education level, payment method of medical treatment, pain duration, average pain duration, or level of pain (all $P > 0.05$). The NP group had a substantially higher NPQ score (8.67±1.21) than the NNP group (6.31±1.34) ($P < 0.05$). The primary causes of NP in the NP group were postherpetic neuralgia (26.23%), diabetic neuropathy (21.31%), and central post-stroke pain (18.03%). The NPQ demonstrated strong reliability, with a Cronbach's alpha coefficient of 0.843 and a Guttman split-half coefficient of 0.822. The ROC analysis showed an AUC of 0.907 (95% CI, 0.853-0.961), with a sensitivity of 86.90%, specificity of 78.30%, PPV of 80.30%, and NPV of 85.45%. Conclusion: NPQ is a reliable and effective tool for identifying neuropathic pain. Its high sensitivity and specificity, coupled with strong diagnostic performance, suggest that it can be used as a screening tool for neuropathic pain.

Keywords: Neuropathic pain questionnaire, neuropathic pain, screening, application effect

Introduction

Neuropathic pain (NP) is pain caused by damage or disease of the somatosensory system or motor nerves. The prevalence of NP in the general population ranges from 3.3%-8.2% [1]. According to the World Health Organization (WTO) statistics [2], NP affects up to 10% of the general population, accounting for more than 30% of all chronic pain types, and about 32.5% of cancer patients suffers cancer-related NP. The condition is marked by high incidence and persistent symptoms, posing significant challenges not only for the patient's prognosis but also placing a substantial burden on both the family and society. Accurate pain assessment is crucial for effective diagnosis and management. The diagnosis of NP primarily relies on clinical history, neurological examination, neuroelectrophysiological tests, and imaging examination. While these methods yield valuable insight, techniques such as skin and nerve biopsies are time-consuming [3], neuroimaging is traumatic and costly [4], and the complexity of NP often complicates the diagnostic process. At present, there are few means for screening and evaluating NP, making its diagnosis in clinical settings even more challenging.

Several diagnostic scales for NP have been developed, validated, and widely recognized, with many available in multiple languages. These include the ID-pain scale, neuropathic pain questionnaire (NPQ) [5], Leeds Assessment of Neuropathic Symptoms and Signs (LANNS), and Douleur Neuropathique 4 (DN4) [6]. These

scales are useful for clinical screening due to their simplicity, lack of need for specialized equipment, and ease of use. However, most of these scales were developed and verified in English or French-speaking environment. In this study, we focus on the NPQ scale, aiming to provide a simple, cost-effective diagnostic tool for use by both doctors and patients in China. Unlike other scales, the NPQ assesses both the nature of the pain and the emotional impact on the patient. Previously, we found that the Chinese version of the NPQ demonstrated good reliability and efficacy, but with high specificity and low sensitivity. This discrepancy may be related to the scale's discriminant coefficient. To further explore the effectiveness of the NPQ in screening for NP, we recalculated its discriminant coefficient.

Patients and methods

Study subjects

This prospective study included patients with chronic pain who were treated and hospitalized at Quanzhou First Hospital between September 2020 and December 2023.

Inclusion criteria: (1) Patients aged ≥18 years or older; (2) Patients with a history of pain lasting more than one year and a fixed pain location. Exclusion criteria: (1) Patients with an unknown cause of pain; (2) Patients with cancer pain, headache, complex regional pain, or visceral pain; (3) Patients with severe depression; (4) Patients with incomplete data and those lost to follow-up. Finally, 121 patients were ultimately included in the study. This study was approved by the Ethics Committee of Quanzhou First Hospital, and all patients provided the informed consent.

In this study, NP was diagnosed according to the *2008 International Association for the Study of Pain (IASP)* [7]: (1) The pain should follow a neuroanatomically logical distribution, consistent with the identified lesion site; (2) The patient's history should suggest involvement of the peripheral sensory system, with conditions such as diabetes, postherpetic neuralgia, or classic trigeminal neuralgia; (3) At least one neurological sign indicative of nerve damage or disease should be present in the area of pain; (4) At least one supplementary examination (e.g., hematology, biochemistry, electrophysiology, neuroimaging, or tissue biopsy) should confirm the presence of lesions or diseases in the somatosensory system. Patients with two or more of these conditions were diagnosed with NP.

Research methods

Data collection

A questionnaire survey and demographic information collection were conducted on eligible subjects before treatment (data obtained from the hospital's case management system). Demographic information collected included age, gender, education level, and nature of medical treatment.

Grouping methods

According to the evaluation results of the NPQ scale, patients were divided into a neuropathic pain (NP) group and a non-neuropathic pain (NNP) group. NP and non-NP were clearly distinguished according to the patient's symptoms.

NPQ scale content

The purpose, significance, and requirements of the questionnaire were explained to the patients by the researchers. After obtaining the informed consents, the questionnaire was distributed and patients completed the survey based on their condition. The questionnaire included 12 items, each scored from 0-10 points, where 0 points indicated no pain, and 10 points indicated severe pain. The content of the scale is shown in **Table 1**. If necessary, a trained investigator was available to clarify any questions or concerns regarding the scale. The NPQ was self-administered by the patients, and the completed questionnaires were collected immediately.

Observation indicators

(1) Baseline data, pain-related conditions, and etiology of the two groups of patients were analyzed. (2) Discriminant coefficient. Taking patients with NP as the classification, Fishier's discriminant method was used to analyze the scores of each item of the NPQ scale they filled out. The non-standardized discriminant coefficient was the Chinese version of the discrimi-

Table 1. Neuropathic pain questionnaire

Subject	Score
1. Please tell us the severity of your pain?	0 painless ☆☆☆☆☆☆☆☆☆☆ 10 very grave
2. Is your pain acute (knife-like, needle-like)?	0 painless ☆☆☆☆☆☆☆☆☆☆ 10 very grave
3. Is your pain a burning sensation (burning sensation, burning sensation)?	0 painless ☆☆☆☆☆☆☆☆☆☆ 10 very grave
4. Whether your pain is dull (blunt, contusion, stuffy pain)?	0 painless ☆☆☆☆☆☆☆☆☆☆ 10 very grave
5. Does your pain feel cold or freezing?	0 no cold pain ☆☆☆☆☆☆☆☆ 10 very grave
6. Is the skin in the affected area sensitive to touch or contact?	0 no sensitivity ☆☆☆☆☆ 10 very sensitive
7. Is there itching in the affected area?	0 no itching ☆☆☆☆☆☆☆☆☆ 10 very grave
8. To what extent does your pain interfere with your daily activities?	0 no effect ☆☆☆☆☆☆☆☆☆☆☆ 10 very grave
9. Does the weather affect your pain?	0 no effect ☆☆☆☆☆☆☆☆☆☆☆ 10 very grave
10. Please describe the discomfort caused by different types of pain.	0 no discomfort ☆☆☆☆☆☆☆☆☆☆ 10 very grave
11. How would you assess your deep pain and its severity?	0 no deep pain ☆☆☆☆☆☆☆☆☆☆☆ 10 very grave
12. How would you assess your superficial pain and its severity?	0 no surface pain ☆☆☆☆☆☆☆☆☆☆ 10 very grave

Table 2. Patients' basic information [n%, (Mean ± SD)]

Item	NNP group (n=60)	NP group (n=61)	χ^2/t	*P*
Age (year)	63.14±7.56	63.75±7.18	0.455	0.649
Gender			0.209	0.648
Male	28 (46.67)	31 (50.82)		
Female	32 (53.33)	30 (49.18)		
Education background			0.263	0.877
Junior high school and below	24 (40.00)	23 (37.70)		
High school or secondary school	19 (31.67)	22 (36.07)		
College, undergraduate and above	17 (28.33)	16 (26.23)		
Payment method of medical treatment			0.198	0.656
At patient's own expense	25 (41.67)	23 (37.70)		
Medical insurance	35 (58.33)	38 (62.30)		

Note: NP, neuropathic pain; NNP, non-neuropathic pain.

nant coefficient, which was the weight of each question of the scale [8]. (3) Reliability evaluation of the scale was assessed using Cronbach's Alpha coefficient and Guttman split-half coefficient. (4) The diagnostic value of NPQ scale was assessed using the receiver operating characteristic (ROC) curve, and the area under curve (AUC), sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were evaluated.

Statistical analysis

Data were analyzed using SPSS 26.0 software. Measured data with normal distribution were expressed as mean ± standard deviation. Independent sample t test was used for comparison between two groups. Enumerated data were expressed as frequency and percentage (n%) and analyzed by χ^2 test. The diagnostic value of NPQ was analyzed using the ROC curve. A *P*-value of < 0.05 was considered significant.

Results

Comparison of patients' basic information between the two groups

A total of 121 questionnaires were distributed, and all 121 were returned, achieving a 100% response rate. Both the NP group and the NNP group contained 60 patients each. Comparisons between the two groups in terms of age, gender, education level, and nature of medical consultation revealed no significant differences (all P > 0.05). See **Table 2** for details.

Comparison of pain-related conditions between the two groups of patients

The two groups showed no significant differences in terms of pain duration or pain intensity, including both the patient distribution of different pain duration/pain intensity and the average duration/VAS score (all *P* > 0.05). See **Table 3** for details.

Table 3. Patients' pain-related conditions [n%, ($\bar{x}$±s)]

Characteristic variable	NNP group (n=60)	NP group (n=61)	χ^2/t	*P*
Pain duration			0.254	0.881
6 months - 1 year	17 (28.33)	16 (26.23)		
1 year - 3 years	23 (38.34)	22 (36.07)		
≥3 years	20 (33.33)	23 (37.70)		
Average pain duration (months)	32.46±9.25	32.79±10.23	0.186	0.853
Level of pain (VAS, score)			0.067	0.967
1≤VAS≤3	18 (30.00)	17 (27.87)		
4≤VAS≤6	20 (33.33)	21 (34.43)		
7≤VAS≤10	22 (36.67)	23 (37.70)		

Note: NP, neuropathic pain; NNP, non-neuropathic pain; VAS, Visual analogue scale.

Table 4. Causes of NP (n%)

Type	NNP group (n=60)	Types	NP group (n=61)
Frozen shoulder	15 (25.00)	Diabetic neuropathy	13 (21.31)
Heel pain	9 (15.00)	Primary trigeminal neuralgia	8 (13.11)
Synovitis	2 (3.33)	Primary glossopharyngeal neuralgia	3 (4.92)
Arthritis	13 (21.67)	Postherpetic neuralgia	16 (26.23)
Cervical and lumbar disc herniation	10 (16.67)	Central post-stroke pain	11 (18.03)
Muscle fasciitis	7 (11.66)	Intercostal neuralgia	6 (9.84)
Tendonitis	1 (1.67)	Complex regional pain syndrome	3 (4.92)
Others	3 (5.00)	Syringomyelia	1 (1.64)

Note: NP, neuropathic pain; NNP, non-neuropathic pain.

Table 5. Typical discriminant function coefficients of NPQ

NPQ question number	Typical discriminant function coefficients
1	0.010
2	0.015
3	-0.007
4	0.009
5	0.008
6	0.006
7	-0.013
8	-0.013
9	0.002
10	0.000
11	0.012
12	-0.006
Constant	-0.934

Note: NPQ, neuropathic pain questionnaire.

Analysis of courses of pain

The main causes of NP of patients in the NNP group were frozen shoulder (25.00%), arthritis (21.37%), cervical and lumbar disc herniation (16.37%). As for patients in NP group, the main causes of their NP were postherpetic neuralgia (26.23%), diabetic neuropathy (21.31%), and central post-stroke pain (18.03%), as displayed in **Table 4**.

Typical discriminant function coefficients of NPQ

The discriminant coefficients calculated based on data from relevant studies in the Chinese population are depicted in **Table 5**.

Reliability assessment of the NPQ

The Cronbach's Alpha coefficient and the Guttman Split-Half coefficient for the NPQ both exceeded 0.8, indicating good reliability of the NPQ scale. See **Table 6** for details.

Validity assessment of NPQ

Based on the discriminant coefficient and the cutoff point (0.016), the ROC curve of the NPQ was plotted, resulting in an AUC of 0.907, with a

Table 6. Cronbach's Alpha coefficient and Guttman split-half coefficient of NPQ

Item	Cronbach's Alpha coefficient	Guttman split-half coefficient
NPQ	0.838	0.818

Note: NPQ, neuropathic pain questionnaire.

Table 7. Sensitivity, specificity, PPV and NPV of the scale

Index	AUC	95% CI	Youden Index	Sensitivity	Specificity	PPV	NPV
NPQ	0.907	0.853-0.961	0.652	86.90%	78.30%	80.30%	85.45%

Note: NPQ, neuropathic pain questionnaire; AUC, Area under curve; PPV, positive predictive value; NPV, negative predictive value.

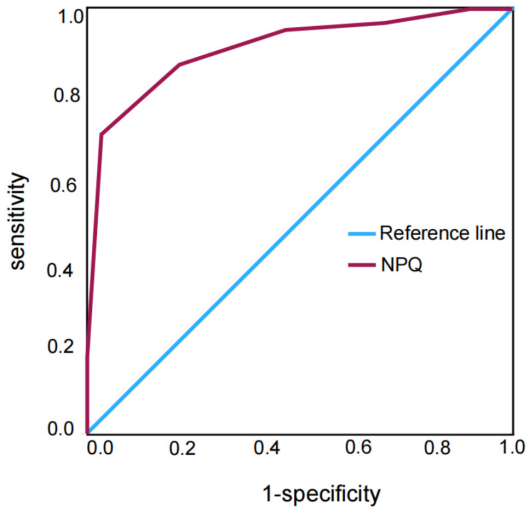

Figure 1. ROC curve of NPQ scale. Note: NPQ, neuropathic pain questionnaire; ROC, receiver operating characteristic.

95% CI of 0.853 to 0.961. For further details, please refer to **Table 7** and **Figure 1**.

Assessment of NPQ scale's diagnostic rate of NP at different cut-off points

Based on data from relevant studies conducted in the Chinese population, the discriminant coefficients were calculated, resulting in a Cronbach's Alpha coefficient of 0.838 and a Guttman Split-Half coefficient of 0.818 for the NPQ, indicating good reliability of the scale. The optimal cutoff point was determined to be 7, suggesting that an NPQ score of 7 or above is indicative of NP, while a score below 7 indicates non-NP. For a detailed examination of the diagnostic value at different cutoff points, refer to **Table 8**.

Discussion

NP originates from nerve damage and is commonly associated with conditions such as shingles, spinal cord injuries, stroke, and diabetes [9]. Its characteristic symptoms include allodynia, electric shock-like pain, prickling sensations, and numbness, with signs such as reduced sensation and lowered pain thresholds. These symptoms form various pain phenotypes that are not directly linked to the underlying causes, since the same disease may present with different symptoms, and different diseases can exhibit similar symptoms [10]. NP often presents in a mixed state, with significant individual variations [11]. Timely and accurate diagnosis and treatment are crucial for preventing chronicity and improving prognosis.

Diagnosing NP relies on clinical signs and auxiliary tests like nerve conduction velocity and trunk evoked potential, though they lack strong specificity [12]. High-specificity sensory tests are costly, and skin biopsies are invasive, making them less patient-friendly. NPQ are favored for their simplicity, no need for high-end equipment, and high sensitivity and specificity, becoming key diagnostic aids for NP globally [13, 14]. They also serve as screening tools in epidemiological studies. Given their development in English or French, a Chinese version is needed for Chinese-speaking patients and doctors, aiming to offer an accessible, low-cost diagnostic option [15-17]. NPQs excel over other scales by assessing pain characteristics and emotional aspects. Studies indicate the Chinese NPQ has good reliability, surface validity, high specificity, and lower sensitivity, possibly due to the original scale's discriminant coefficient [18]. Using validated NP assessment tools in clinical settings is crucial.

The NPQ was initially developed based on a comprehensive review of symptom descriptions in numerous NP literature, resulting in a preliminary scale with 32 items. Through statistical analysis, this was streamlined to a concise

Table 8. NPQ scale's diagnostic rate of NP at different cut-off points

Cut-off point (points)	Youden Index	Sensitivity	Specificity	PPV	NPV
≥6	0.484	95.1%	46.7%	64.44%	90.32%
≥7	0.652	86.90%	78.30%	80.30%	85.45%
≥8	0.672	70.50%	96.70%	95.55%	76.32%

Note: PPV, positive predictive value; NPV, negative predictive value.

version comprising 12 items. These 12 questions encompass a variety of sensory abnormalities, such as numbness, which is a form of hypoesthesia, often indicating damage or pathology in peripheral or central sensory pathways; and paresthesia, which is not a traditional pain sensation but rather the spontaneous activity of A-β fibers, associated with the repair activities of damaged nerves [19]. The NPQ scale not only measures common problems such as burning pain, oversensitivity, cold pain, and negative emotions caused by pain, but also includes the effects of shooting pain, compression pain, numbness, tingling, electric shock pain, and weather changes on pain [20]. Therefore, NPQ can comprehensively evaluate the characteristics of NP from multiple perspectives. In some studies [21-23] on NP, the causes of NP include diabetic neuropathy, postherpetic neuralgia and lumbar nerve root pain. In this study, the main causes of NP of patients in the NP group were postherpetic neuralgia (26.23%), diabetic neuropathy (21.31%), and central post-stroke pain (18.03%), essentially in line with earlier research's conclusions. According to the results of the questionnaire, the type and level of pain will change over time. Thus for clinical treatment of NP, the level and type of pain should be identified. Repeated investigation by using the NPQ, especially questions about the symptoms and level of pain, can help identify patients, so as to observe the entire process of pain and guide doctors in developing treatment.

Verification of the NPQ can be carried out from two aspects, reliability and validity. The commonly used test methods for reliability are Cronbach's Alpha coefficient and Guttman split-half coefficient, which analyze the reliability of the scale from different perspectives. The higher the value, the better the internal consistency of the scale, and the general reliability should be greater than 0.7. In practical application, the Cronbach's Alpha coefficient of the NPQ scale calculated based on Chinese population data is 0.838, and the Guttman split-half coefficient is 0.818, both exceeding the standard of 0.8, which indicates that the scale has high reliability and internal consistency in the screening process, and the surface validity is good. Additionally, relevant studies [24] have also confirmed that the Chinese version of the NPQ questionnaire maintains a high level of consistency and stability. The validity of the scale is analyzed from two aspects: face validity and content validity. Face validity refers to the assessment of the scale's professionalism, accuracy, and operability by experts in the relevant field. The NPQ questionnaire has been thoroughly discussed by pain specialists from multiple research centers and has been proven to exhibit excellent face validity [25, 26]. Studies have indicated that in the assessment of content validity, common indicators include AUC, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) [27]. The AUC reflects the balance between sensitivity and specificity, with its value ranging between 0.5 and 1. The closer the AUC value is to 1, the better the diagnostic performance, indicating a high accuracy in distinguishing between conditions. For diagnostic tests, when the AUC value is between 0.5 and 0.7, the diagnostic value is considered to be low; between 0.7 and 0.9, the diagnostic value is moderate; when above 0.9, the diagnostic value is considered to be higher. In this study, the NPQ screening for NP yielded an AUC of 0.907, with a 95% CI ranging from 0.853 to 0.961, and a Youden's index of 0.652. The sensitivity was 86.90%, the specificity was 78.30%, the positive predictive value was 80.30%, and the negative predictive value was 85.45%. These results indicate that the NPQ has a high diagnostic value and excellent content validity. The study also evaluated the diagnostic performance of different cutoff scores for the NPQ and determined that the optimal cutoff point was 7. This means that a score of 7 or above on the NPQ indicates a diagnosis of NP, while a score below 7 suggests non-NP. It can be seen that the content validity

of the Chinese version of the NPQ scale was considered to be good, and has been widely recognized and verified by experts, which provides a solid scientific basis for its application in the Chinese patient population [28, 29]. Additionally, the NPQ not only excels in screening and diagnostic performance but also covers multiple dimensions, including the effect of pain on emotions and the effects of weather changes on pain. It can effectively distinguish NP and holds unique value in diagnosing NP [30].

The NPQ is a patient-completed questionnaire. During the scale's development for this study, discriminant analysis was used, which means each question was weighted by a discriminant coefficient. Consequently, to ascertain the presence of NP, the final score must be calculated using a specific formula, a process that necessitates a bit of time. In addition, NPQ is completely based on the patient's symptoms to distinguish between NP and nociceptive pain, there is no corresponding physical examination as an auxiliary basis. Although NPQ is not the best screening tool for NP, it can be applied to different subjects to improve its effectiveness in screening patients with NP. Currently, most of the scales or questionnaires used for screening NP in China are imported from abroad, with few developed based on domestic conditions. It is imperative for clinical medical staff to actively attempt to develop new screening tools for NP, guiding them to provide more effective and high-quality services to patients and addressing the shortcomings of existing NP assessment tools. We look forward to more related research in the future, providing more robust evidence from an evidence-based medicine perspective on the effectiveness of NPQ screening, offering a reference for the study of NP screening tools [30].

In summary, NP is a chronic, severe, and persistent type of pain, making early and definitive diagnosis crucial. The NPQ questionnaire is straightforward and easy to understand, with no requirements for cultural literacy, and it boasts high diagnostic performance. Patients for whom Chinese is their native language can effortlessly use the NPQ scale validated in this study, facilitating its adoption in primary healthcare settings and serving as a tool for early screening and diagnosis of NP patients.

Innovation: The innovation of this study is to introduce the Chinese version of the pathological pain scale, and to increase the early screening method for the diagnosis of NP for clinical and scientific research.

Limitations: First, the sample size of this study was relatively small, and the study period was one year, which may have affected the generalizability and long-term validity of the results. Secondly, although the NPQ questionnaire has high sensitivity and specificity, there are differences in specificity and sensitivity among various scales, possibly leading to false-positive outcomes. Lastly, while the NPQ is comprehensive, it may need to be adjusted according to the specific circumstances of patients in practical applications, and a single scale may not be sufficient to make a definitive diagnosis. It should be combined with other clinical information and examination results. Therefore, caution is needed when applying the NPQ in clinical practice, and it is hoped that future studies will further validate the evaluative efficacy of the NPQ questionnaire.

Conclusion

NPQ is effective in identifying NP. Due to its high level of sensitivity and specificity together with good performance in diagnosis, NPQ can be a screening tool for identifying NP.

Disclosure of conflict of interest

None.

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