Comparison of Median Nerve Mechanosensitivity and Pressure Pain Threshold in Patients With Nonspecific Neck Pain and Asymptomatic Individuals

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Abstract

Objective: The purpose of this study was to investigate the presence of median nerve mechanosensitivity by comparing median nerve neurodynamic test results of patients with nonspecific neck pain (NNP) and asymptomatic individuals.

Methods: A total of 40 patients (30 women, 10 men) with NNP between the ages of 21 and 62 years (39.53 ± 10.18 years) and 38 asymptomatic individuals (23 women, 15 men) between the ages of 18 and 60 years (37.13 ± 9.64 years) participated in the study. Pressure pain threshold was assessed with digital pressure algometer, cervical joint range of motion was assessed with a universal goniometer, and median nerve mechanosensitivity was assessed with Upper Limb Neurodynamic Test 1 (ULNT1). The test step where the first sensory response was given, the location and character of the sensory response, and the final elbow extension angle were recorded during ULNT1.

Results: Patients with NNP had significantly decreased pressure pain threshold ($P < .001$), decreased range of motion of cervical flexion ($P < .001$), and decreased cervical lateral flexion ($P = .001$) compared with asymptomatic individuals, whereas no change was identified in range of motion of rotation ($P = .100$). In ULNT1, 45% of patients with NNP reported pain and 40% of them reported stretch. A total of 65% of asymptomatic individuals reported stretch, and 13% of them reported pain. It was identified in ULNT1 that final elbow extension angle was lower in the NNP group compared with asymptomatic individuals ($P = .008$).

Conclusion: Median nerve mechanosensitivity increased, pressure pain threshold decreased, and active neck motion was limited in individuals with NNP compared with asymptomatic individuals. (J Manipulative Physiol Ther 2018;41:227-233)

Key Indexing Terms: *Neck Pain; Median Nerve; Pain Threshold; Neuralgia*

Introduction

Neck pain is among the 4 most commonly reported diseases of the musculoskeletal system.[1-5] The high prevalence of neck pain and its effects on function and job performance are important problems for patients and society.[6] The characteristic of nonspecific neck pain (NNP) is unclear; it is not known with certainty whether it is a nociceptive pain or neuropathic pain.[7] The pain perceived as a result of the activation of nociceptors that are related to real or potential damage of nonneural structures is called nociceptive pain, whereas the pain perceived as a result of damage to somatosensory system is called neuropathic pain.[8,9] In neuropathic pain, excitability of neurons increases because of sensitivity of the central nervous system or the peripheral nervous system or both.[10] Neural sensitivity is thought to be a mechanism protecting nerves against mechanical stress occurring during movement.[11] Literature on neural mechanosensitivity in NNP is both limited and conflicting.[12,13] Assessment of increased peripheral nerve mechanosensitivity with neurodynamic tests is important in terms of determining the potential neural damage that might associated with neck pain.[14]

Upper limb neurodynamic tests consist of 4 different neurodynamic tests used in the diagnosis of neck pain and neurogenic conditions in the upper limbs without neck pain.[15] These tests were developed to assess the movement capability of peripheral nerves during upper limb movements.[16] Mechanical stress in the brachial plexus and/or spinal nerve

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and/or nerve root is induced during these tests. Symptoms that indicate increased nerve sensitivity as a result of mechanical stress include muscle spasm, endpoint sensation, and abnormal motor responses. Compression applied by neighboring structures and ischemia occurring in the nerves as a result of stress are thought to cause these symptoms.[17]

In previous studies, it was reported that upper limb neurodynamic tests except for median nerve Upper Limb Neurodynamic Test 1 (ULNT1) had high sensitivity in the diagnosis of neck radiculopathy and produced symptoms even in the absence of any problems. For this reason, it is quite difficult to interpret results of radial and ulnar nerve tests. On the other hand, the median nerve neurodynamic test was reported to be the only and the best test in elimination of cervical radiculopathy.[18,19] The number of studies investigating median nerve mechanosensitivity in NNP is limited.[20-22] Thus, the aim of our study was to assess differences present in patients with NNP regarding neural mechanosensitivity of the median nerve comparing those with healthy individuals. We hypothesized that individuals with NNP would report sensory responses in earlier stages of the ULNT1 compared with asymptomatic individuals; their sensory responses would have a different character, and elbow extension measured during the test would be limited. Therefore, patients with NNP would present greater mechanosensitivity than those with healthy individuals when the neural test was applied.

Materials and Methods

Sample Size Calculation

The sample size was calculated based on a previous study that was conducted by Coppieters et al.[20] It was estimated that 35 individuals for each group had to be included in this study for 90% power with 5% type I error level to detect a minimum clinically significant difference of 15° for elbow extension angle at ULNT1, when the avarage value in the control group was 159°, with a standard deviation of 17°. However, to account for dropouts, we decided that 40 patients for the NNP group and 38 asymptomatic individuals for control group would be recruited for this study.

Participants

A total of 40 patients (30 women, 10 men) between the ages of 21 and 62 years (mean age 39.53 ± 10.18 years) diagnosed with chronic NNP (longer than 3 months in duration) as a result of clinical examination and radiologic findings were included in this study. The asymptomatic group consisted of 38 pain-free individuals (23 women, 15 men) with an age range of 18 to 60 years (mean age 37.13 ± 9.64 years) who had not experienced neck pain for at least 1 year before the study. Participants were excluded if they had central nervous system disorders, root compression, distal peripheral nerve injury, nonsystemic arthritis, or cervical spine and upper limb fracture; had undergone cervical spine or upper limb surgery; or had limited joint motion in the upper limb and bilateral upper limb symptoms. They were also excluded if they had received any form of treatment (eg, physiotherapy, chiropractic, acupuncture, massage, nonsteroidal anti-inflammatory drugs, or local injection) in the previous 6 months. Ethical approval for this study was obtained from Hacettepe University's Non-invasive Clinical Research Ethics Committee (GO 13/366-08). Written consent forms were signed by all particpants included in the study.

Physical Measurements

Pressure Pain Threshold. Pressure pain threshold was assessed with digital pressure algometer (Commander Algometer, JTECH Medical, Midvale, Utah). Assessments were made from the middle point of both upper trapezius using 1 cm^2 tip and the minimum pressure causing pain during the measurement was recorded in kilograms per square centimeter (kg/cm^2). Measurements were repeated 3 times and averaged.

Active Neck Movement. Cervical joint range of motion was measured with 360° universal goniometer in an erect sitting position. The participants performed each movement 3 times, being encouraged to move as far as possible each time. The mean of triplicate readings for each direction was calculated.

Mechanosensitivity of the Median Nerve. Median nerve mechanosensitivity was assessed with ULNT1, which is one of the upper limb neurodynamic tests. The test was applied in the standardized position described by Butler.[16] To perform the test, all participants were asked to lie supine. ULNT1 was performed in the following sequence (Fig 1):

1. Gentle shoulder girdle depression, glenohumeral abduction, and external rotation in the coronal plane, and wrist and finger extension and elbow extension. The angle of elbow extension was measured at submaximal pain threshold using a standard goniometer aligned along the midhumeral shaft, medial epicondyle, and ulnar styloid.
2. If no pain was experienced, elbow extension was continued to the end of normal physiological range.
3. If no sensory response was reported at the end of the elbow extension, the neck was taken to lateral flexion of the other side.

Test steps were applied throughout the entire movement range of the participant or until the participant asked for the test to be ended. In case of sensory response (pain, burning, numbness, ache, pressure, tightness, tingling) at any step of ULNT1, the test stage and the location (neck, shoulder, arm, elbow, forearm, and hand) of the symptom were

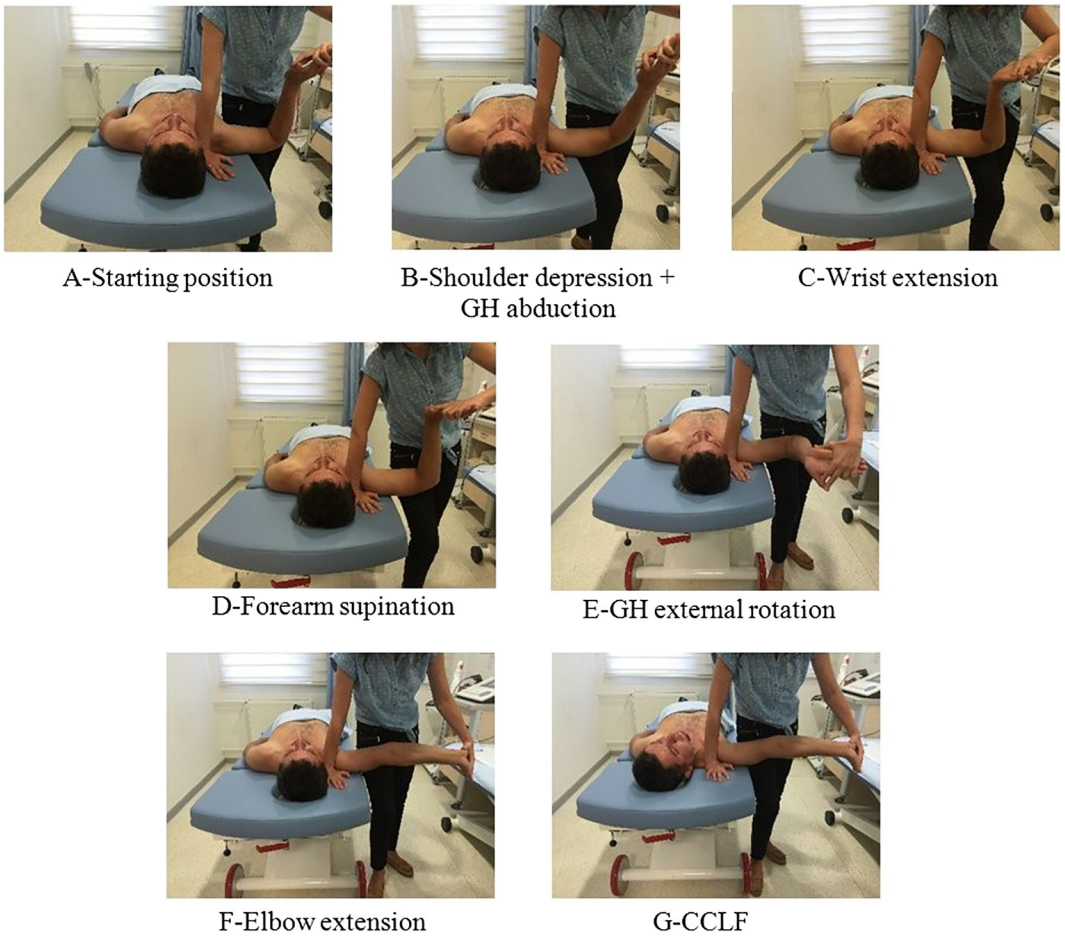

Fig 1. *Upper Limb Neurodynamic Test 1 stages (A-G).* CCLF, *contralateral cervical flexion;* GH, *glenohumeral.*

recorded. The test was applied twice in a single session with 1-minute rest intervals and the mean of 2 assessments was calculated and recorded.[16] All measurements were taken by the same author who had undergone training and was experienced in performing all the tests in this study. Participants attended 1 test session.

Statistical Analysis

SPSS for Windows Version 18 (SPSS Inc., Chicago, Illinois) was used for statistical analysis. Compatibility of variables to normal distribution was investigated with visual (histogram and probability charts) and analytical methods (Kolmogorov-Smirnov or Shapiro-Wilk tests). The demographic data and the results related to pressure pain threshold, joint movement range, and elbow extension angle measured during ULNT1 were given as mean ± standard deviation (SD), whereas the results related to the test step, location, and character of the sensory response were given as percentages (%). The demographic data and the results related to pressure pain threshold, joint movement range, and elbow extension angle measured during ULNT1 of the NNP group and the control group were compared using the Mann-Whitney *U* test. Correlation coefficients for interrelations between parameters and statistical significance were calculated using the Spearman test. Type I error was accepted to be .05 for statistical significance.

Results

As a result of the statistical analysis, no significant difference was found between patients with NNP and asymptomatic individuals in terms of age ($P = .172$), height ($P = .113$), weight ($P = .558$), or body mass index ($P = .646$). It was determined that patients with NNP had significantly decreased pressure pain threshold compared with asymptomatic individuals ($P < .001$). Patients with NNP had decreased cervical flexion ($P < .001$) and cervical lateral flexion ($P = .001$) compared with asymptomatic individuals, whereas no change was identified in terms of rotation ($P = .100$; Table 1).

The ULNT1 step at which the first mechanosensitivity was identified was elbow extension for 60% of the NNP group and

Table 1. *Demographic Data and the Results of Pressure Pain Threshold, ULNT1, and Cervical Range of Motion of Patients With NNP and Asymtomatic Individuals*

	Patients With NNP (n = 40)	Asymptomatic Individuals (n = 38)	*P*
Age, y	39.53 ± 10.18	37.13 ± 9.64	.172
Height, m	1.67 ± 0.11	1.69 ± 0.09	.113
Weight, kg	69.3 ± 14.77	69.75 ± 12.76	.558
BMI, kg/m^2	24.63 ± 4.13	24.39 ± 3.10	.646
Pressure pain threshold, kg/cm^2	49.54 ± 17.99	70.00 ± 22.21	<.001 [a]
ULNT1, °	165.79 ± 14.76	175.41 ± 7.99	.008 [a]
Cervical flexion + extension	84.60 ± 14.56	96.37 ± 7.66	<.001 [a]
Cervical lateral flexion	74.33 ± 14.24	83.34 ± 9.91	.001 [a]
Cervical rotation	129.30 ± 11.73	134.34 ± 10.17	.100

BMI, body mass index; *NNP,* nonspecific neck pain; *ULNT1*, Upper Limb Neurodynamic Test 1.
[a] $P < .05$, Mann-Whitney *U* test.

79% of the asymptomatic group (Fig 2). In ULNT1, patients with NNP reported more pain (45%) and less stretch (40%) compared with asymptomatic individuals, who reported stretch (65%) and pain (13%) as well (Fig 3). It was determined that final elbow extension angle in ULNT1 was lower in the NNP group compared with asymptomatic individuals ($P = .008$). A moderate correlation was identified between pressure pain threshold and final elbow extension angle in ULNT1 ($r = 0.47$, $P = .002$) in patients with NNP, whereas no correlation was identfied between these parameters ($r = 0.14$, $P = .421$) for asymptomatic individuals.

Discussion

The results of this study indicated that patients with NNP had greater median nerve mechanosensitivity during neurodynamic testing than asymptomatic individuals. In addition to these results, it was determined that pressure

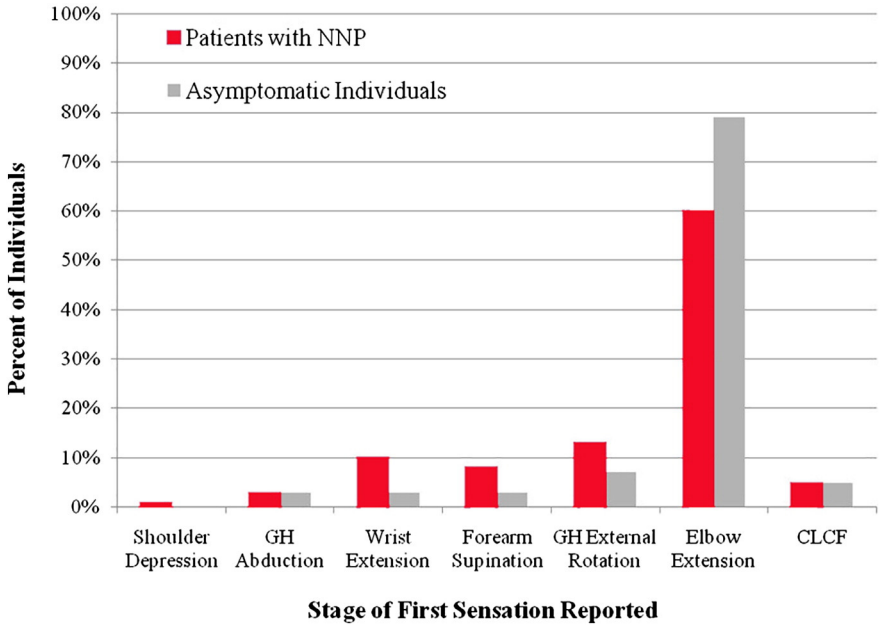

Fig 2. *Distribution of test stage at which the first mechanosensitivity was observed in Upper Limb Neurodynamic Test 1.* CLCF, *contralateral cervical flexion;* GH, *glenohumeral;* NNP, *nonspecific neck pain.*

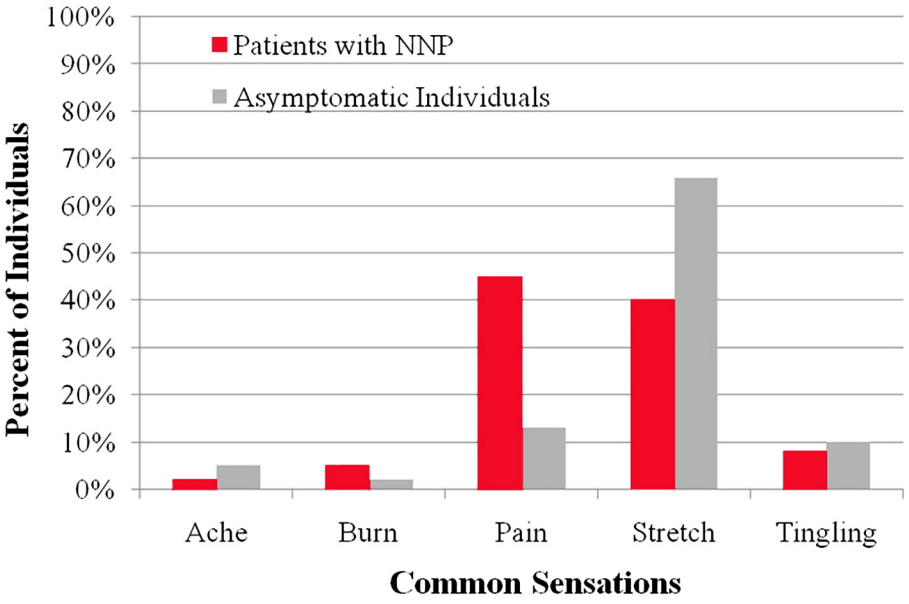

Fig 3. *Distribution of the character of the first mechanosensitivity observed in Upper Limb Neurodynamic Test 1.* NNP*, nonspecific neck pain.*

pain threshold and active neck movements decreased in patients with NNP. These results indicated that median nerve mechanosensitivity could develop in patients with NNP. Our results are consistent with those of the study by Villanueva et al.[21] In their study to assess differences in neural mechanosensitivity between patients with chronic NNP with and without neuropathic features (NF), patients with chronic NNP with NF developed symptoms much earlier than patients in the no-NF group in tests focused on increasing neural tension, indicating greater mechanosensitivity in the NF group.[21] Unlike our results, Scott et al[22] identified widespread sensory hypersensitivity in a group with whiplash-associated disorders, whereas no change in the group with chronic idiopathic neck pain was reported in terms of pressure pain thresholds measured from median, ulnar, and radial nerves; heat pain thresholds; cold pain thresholds; and von Frey hair sensibility. Different results of the studies in the literature may be due to failure to group patients with pain according to neuropathic features, assessment of a patient group consisting mostly of patients with neuropathic pain, or assessment of neural mechanosensitivity using different methods. In our study, the findings revealing that the most commonly reported sensory response during ULNT1 in the NNP group was pain and that the elbow extension angle of this group was decreased might indicate that peripheral nerve structure of this group may be affected. The tension occurring in the median nerve during the test is known to cause pain response by stimulating primary afferent neurons in inflamed nerve tissue.[17] Contrary to the common idea that NNP has a nociceptive character, the results of our study that indicated increased median nerve mechanosensitivity in NNP led to the idea that the pain might have a neuropathic character and increased mechanosensitivity might signal a neural pathologic condition before sensory and motor loss.

Decreased pressure pain thresholds of individuals with neck pain in our study indicate the presence of mechanical hyperalgesia. There are numerous studies reporting that mechanical hyperalgesia is a sign of nerve damage.[23-25] In our study, the decrease in pressure pain threshold and relationship between pressure pain threshold and final elbow extension angle in ULNT1 are believed to be associated with the increase in nerve mechanosensitivity.

It was noted that all cervical movements except for cervical rotation decreased in patients with NNP compared with asymptomatic individuals. We believed that one of the reasons behind this limitation was pain. Pain stimulus leads to an increase in activity between nerves in the spinal cord. Increased motor neuron activity results in muscle spasm and more stimuli in pain area.[26] Also, it must be taken into account that this muscle spasm might occur as a result of a small nerve pathologic condition and protective muscle mechanism for nerves. As a result, pain and muscle spasm cause a limitation in the range of joint motion. Cervical contralateral flexion, flexion, and contralateral rotation are components that increase median nerve tension.[16] We believe that limited cervical active movement in the NNP group in our study might be a compensatory mechanism aimed at reducing median nerve tension.

Changes in median nerve mechanosensitivity, pressure pain threshold, and joint motion range identified in our study indicated that NNP might have a neuropathic character and confirmed the hypotheses of the study. As a result, it was determined that the median nerve neurodynamic test was a clinically important test allowing for determination of neural mechanosensitivity in the early stages of NNP. We believe

that the test could be used by health professionals to determine the pain character of NNP and create a treatment program thanks to its low cost and easy and quick application.

Study Limitations

This study had some limitations. The researcher making the assessment was not blind to groups, and this could have affected the results of the study. Also, it was possible to assess the change in median nerve mechanosensitivity with pressure pain measurements from median nerve in addition to trapezius muscle, yet pressure pain measurements were made only from trapezius muscle in our study.

Conclusions

Median nerve mechanosensitivity increased, pressure pain threshold decreased, and active neck motion was limited in individuals with NNP compared with asymptomatic individuals. These results indicated that NNP might have a neuropathic character and neural structures should be taken into account from an early stage in assessments and treatment approach.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): S.Y., S.T., Ö.T.Y.
Design (planned the methods to generate the results): S.Y., S.T., Ö.T.Y.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): S.Y., S.T., Ö.T.Y.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): S.Y., S.T.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): S.Y., S.T., Ö.T.Y.
Literature search (performed the literature search): S.Y., S.T., Ö.T.Y.
Writing (responsible for writing a substantive part of the manuscript): S.Y., S.T., Ö.T.Y.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): S.Y., S.T., Ö.T.Y.
Other (list other specific novel contributions): S.Y., S.T., Ö.T.Y.

Practical Applications

- Active neck movements decreased in individuals with NNP compared with the healthy individuals.
- Pressure pain threshold decreased in individuals with NNP compared with the healthy individuals.
- Individuals with NNP demonstrated increased median nerve mechanosensitivity during median nerve neurodynamic test.

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