RESEARCH ARTICLE

Reliability of Diagnostic Tests for Movement System Impairment-based Categories of Mechanical Neck Pain

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Received: 26 April 2024 *Accepted: 22 September 2024*

Abstract

Objectives: The aim of the current study was to investigate the inter-tester reliability of the MSI classification test items in patients with neck pain.

Methods: sixty subjects with neck pain (18-65 years) participated in this cross-sectional study. The examination of each patient, included the evaluation of signs and symptoms during posture and movement tests and the MSI diagnosis of subjects with cervical pain, was performed simultaneously by three testers in one session. Kappa and gamma values were used to determine the measure of agreement between testers for each of the test items and classification judgment.

Results: The kappa values for inter-tester reliability of the sign items ranged from 0.36 to 1. For the symptom items kappa values ranged from 0.36 to 1. The kappa values of inter-tester reliability for patients' classification judgments ranged from 0.71 to 0.73.

Conclusion: The inter-tester reliability between three testers according to the MSI approach for neck pain classification, sign and symptom was generally acceptable.

Level of evidence: III

Keywords: Classification, Impairment, Mechanical neck pain, Movement system, Reliability

Introduction

Neck pain is one of the most common musculoskeletal disorders resulting from repeated neck movements or sustained postures of the cervical spine.[1-3] Chronicity is the most prevalent consequence of neck pain.[4-7] Between 50% and 85% of these patients experience new episodes of neck pain shortly after the symptoms subsided, and the others develop chronic neck pain.[8] This condition leads to significant medical costs for society, absence from work, and disability for individuals.[9,10] Hence, mechanical neck pain is a challenging issue for the healthcare sector.

Effective treatment procedures should be able to alleviate symptoms and reduce complications in individuals with neck pain.[11,12] However, based on the results of a systematic review, the evidence for the effect size of exercise therapy in the treatment of chronic neck pain is low or heterogeneous.[13] It has been recommended that classifying disorders such as neck pain into mutually exclusive groups (based on signs and symptoms) can increase the effectiveness of treatment procedures.[14-16] It has been suggested that categorizing patients into homogeneous sub-groups and performing a specific treatment for each sub-group may improve treatment results.[15-20] Hence, it seems that classifying people with neck pain is an important step for improving the quality of the clinical treatment process.[21]

One of the clinical models in which a classification system has been proposed for neck pain is the movement system

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THE ONLINE VERSION OF THIS ARTICLE ABJS.MUMS.AC.IR

impairments model introduced by Dr. Shirley Sahrmann.[21] This model identifies four distinct sub-groups for neck pain: flexion-rotation, extension-rotation, flexion, and extension. Based on this model, repetitive or incorrect movements and postures in different directions may lead to neck pain.[14] Hence, Movement System Impairment (MSI) sub-groups are based on the direction of painful movements and postures. The examination consists of alignment and movement tests in a variety of positions to determine the type of neck pain in the patient.[22,23] It is proposed that by performing these examinations, the neck pain sub-group is identified based on the direction of the movements that cause symptoms.

It is essential to establish the reliability of physical examination items associated with the MSI approach when conducted by various examiners for patients suffering from neck pain. Some studies have investigated the reliability of clinical tests in patients with neck pain.[24-27] However, none of them examined inter-tester reliability for neck pain based on the MSI approach. Therefore, the current study investigated the inter-tester reliability of the MSI classification test items in patients with neck pain. We hypothesized that the reliability of the sign and symptom items was acceptable and patient classification into subgroups was reliable.

Materials and Methods

Study design

This study was a cross-sectional study that received approval from the Ethics Committee of the Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1401.081). All tests were investigated at the Musculoskeletal Rehabilitation Research Center of Ahvaz Jundishapur University of Medical Sciences. Data collection took place from 28 May 2022 to 30 November 2022. This article was reported according to the Guidelines for Reporting Reliability and Agreement Studies.[28]

Subjects

A total of 60 subjects with neck pain were participated. The demographic profile of the participants is presented in [Table 1]. The patients were recruited from a local hospital physical therapy clinic. An experienced physical therapist screened participants according to the inclusion and exclusion criteria. The inclusion criteria were an age range of 18-65 years, a primary complaint of neck pain with or without upper extremity symptoms, and a minimum pain intensity of three out of ten based on a visual analog scale (VAS). On the other hand, the exclusion criteria were pregnancy, severe kyphosis or scoliosis, ankylosing spondylitis, inability to stand and walk without an assistive device, cervical or thoracic spine fracture, torticollis, fibromyalgia, recorded malignancy, known neurologic or rheumatologic diseases, a history of surgery or trauma in the spine, upper extremities, shoulder or thorax, and insufficient Persian language skills necessary to complete all questionnaires.[26,27,29]

Table 1. Demographic information of participants

Gender	**n (%)**
Male	11 (18.3%)
Female	49 (81.7%)
Age (year)	
Mean (SD)	40.95 (11.12)
Median	39.00
Range	21-65
Height (cm)	
Mean (SD)	162.70 (7.22)
Median	161.50
Range	146-178
Weight (kg)	
Mean (SD)	71.55 (13.55)
Median	70.00
Range	48-110
Duration of current neck pain (month)	
Mean (SD)	25.50 (41.13)
Median	12
Range	3-240
Location of current symptoms	**n (%)**
Neck	1 (1.7%)
Neck-scapular	4 (6.7%)
Neck-suboccipital	1 (1.7%)
Neck-scapular-suboccipital	9 (15%)
Neck-radicular to upper extremity	7 (11.7%)
Neck-scapular-radicular to upper extremity	13 (21.7%)
Neck-suboccipital-radicular to upper extremity	2 (3.3%)
Neck-scapular-suboccipital-radicular to upper extremity	23 (38.4%)

Table 1. Continued

History of previous neck pain	
Yes	44 (73.3%)
No	16 (26.7%)
VAS	
Mean (SD)	6.07 (2.12)
Median	6.00
Range	3-10
NDI	
Mean (SD)	32.25% (16.30)
Median	30%
Range	4%-80%

VAS: Visual Analog Scale/ NDI: Neck Disability Index

Testers

Three physical therapists participated as testers. Their clinical experience ranged from six to seventeen years, and they had been using the MSI approach for four to eight years. However, before starting the study and for coordination among testers, all three physiotherapists were trained through a 12-hour course that encompassed both theoretical and practical training, as well as watching training videos. At the end of the theoretical training (four hours), they completed a chart for neck examinations, and each examiner received a booklet containing the necessary practical definitions, the method of categorizing and diagnosing the type of neck pain, and the method of performing each test. In the practical training section, testers passed an eight-hour practical course to master the details of the physical examination process based on the MSI approach.

Data collection

On the day of testing, medical history, the severity of symptoms, and the level of pain and neck disability were taken from each participant.

Pain

Pain intensity was measured using a VAS scale, indicating zero as no pain and ten as “the worst imaginable pain.” The participants were asked to report their mean pain intensity at the time of the test session.[30]

Neck disability level

The Persian version of the Neck Disability Index Questionnaire was used to assess the effects of neck pain in daily activity. This questionnaire evaluates individuals' functional limitations and disability levels. The scores of each section are added up and expressed as a percentage. The validity and reliability of this questionnaire are acceptable (intra-class correlation coefficient ranged from 0.90 to 0.97).[31,32]

Examination

During the examination, each tester recorded the findings on a particular data form. The assessment of each patient included the evaluation of signs and symptoms during both primary and secondary active movement and alignment tests based on the method proposed in the clinical model of movement system impairments.[33] In primary movement tests, the patient performed an active movement with the desired pattern and then reported changes in the intensity and location of their symptoms. In these tests, every patient was asked to report symptoms in the specified position after 10 seconds.[34] Secondary tests were performed when the patient reported an increase or peripheralization of symptoms in the primary tests.[33] each tester was blinded to the judgment made by other testers. For each participant, one tester was responsible for conducting clinical tests and examinations. The other two therapists were observing the examinations. The examiners did not discuss with each other during the tests and recorded examination findings on separate forms. In order to control the effect of repeated testing, all testers assessed patients at the same time. Prior to commencing the assessments, response options (increased symptoms, decreased symptoms, unchanged symptoms) were clearly defined for all examiners to minimize variability in the results.[34]

Data analysis

Kappa and gamma values were used to determine the measure of agreement between examiners for each of the test items and classification judgment in the subjects with neck pain. We used reliability scores to interpret the results: poor agreement (kappa values <0.40), fair agreement (0.40-0.59), good agreement (0.60-0.74), and excellent agreement (kappa values ≥0.75). A Kappa value above 0.4 is generally considered acceptable.[18,30,35] Gamma is a measure of association for ordinal variables. They are calculated in pairs. All pairs ranked in the same order are considered "congruent," whereas all pairs ranked in the reverse order are considered "incongruent". Gamma scores range from -1.00 to 1.00, where a gamma of 0.00 reflects no association, a gamma of 1.00 reflects a positive perfect relationship between variables, and a gamma of -1.00 reflects a negative perfect relationship between those variables.[36]

Results

The results of the kappa value and gamma value for all examined items (signs and symptoms) are shown in Tables 2 to 4. These values could not be calculated for some evaluated items because there was no variance between the answers, and they were constant. These items are presented in [Tables 2 and 3].

Sign

The range of kappa values for sign items was between 0.36 and 1 [Table 2]. Of the 23 items that were used for alignment and movement assessment, 13 items had excellent reliability, 3 items had good reliability, 4 items had fair reliability, and 3 items had poor reliability. Gamma values for sign items ranged between -0.007 and 0.008, while calculations for the other items were not possible [Table 2].

Symptom

For symptom items, kappa values ranged from 0.36 to 1 [Table 3]. Ten items had excellent reliability, two items had good reliability, one item had fair reliability, and one item had poor reliability [Table 3]. Gamma values ranged from -0.007 to + 0.008. Gamma value could not be measured for only one item [Table 3].

Table 2. Sign items: unit of measurement, Kappa and Gamma values, Inter-tester

Physical examination item	Unite of measurement	Inter-tester Kappa	Inter-tester Gamma
***Standing**			
Neck Alignment- anterior & posterior view			
Normal	Yes/No	0.49 (0.38, 0.61)	0.005 (-0.062, 0.072)
Asymmetric	Yes/No	0.36 (0.26, 0.46)	0.008 (-0.06, 0.076)
Neck Alignment- Lateral view			
Forward translation	Yes/No	0.94 (0.79, 1.09)	0 (-0.084, 0.084)
Neck extension	Yes/No	0.67 (0.48, 0.86)	-
Neck flexion	Yes/No	0.92 (0.78, 1.07)	0 (-0.085, 0.085)
Scapular Alignment			
Normal	Yes/No	0.37 (0.21, 0.53)	-
Depression	Yes/No	0.65 (0.51, 0.80)	0 (-0.082, 0.082)
Abduction	Yes/No	0.89 (0.72, 1.06)	-
Downward rotation	Yes/No	0.95 (0.80, 1.09)	0 (-0.084, 0.084)
Thorax Alignment			
Kyphosis	Yes/No	0.84 (0.63, 1.05)	-
Neck rotation with unilateral shoulder flexion	Yes/No	0.37 (0.20, 0.54)	-
Neck extension with unilateral shoulder flexion	Yes/No	0.74 (0.59, 0.89)	-
Neck extension with bilateral shoulder flexion	Yes/No	0.97 (0.82, 1.12)	0 (-0.084, 0.084)
***Sitting**			
Decreased active neck rotation	Yes/No	0.81 (0.66, 0.95)	0.003 (-0.087, 0.093)
Decreased active neck extension	Yes/No	0.86 (0.71, 1.01)	0.002 (-0.084, 0.089)
Decreased active neck flexion	Yes/No	0.40 (0.23, 0.57)	-
Neck rotation with unilateral shoulder flexion	Yes/No	0.78 (0.59, 0.97)	-
Neck extension with unilateral shoulder flexion	Yes/No	0.86 (0.72, 1.01)	-0.007 (-0.089, 0.076)
Neck extension with bilateral shoulder flexion	Yes/No	0.84 (0.67, 1.01)	-
***Supine**			
Decreased active neck rotation	Yes/No	1 (0.85, 1.14)	-
***Prone**			
Translation with neck extension	Yes/No	0.46 (0.32, 0.61)	-
***Quadruped**			
Decreased active neck rotation	Yes/No	0.74 (0.593, 0.887)	-0.005 (-0.085, 0.076)
Ext with backward rocking	Yes/No	0.95 (0.80, 1.10)	0 (-0.088, 0.088)

Table 3. Symptom items: unit of measurement, Kappa and Gamma values, Inter-tester

Physical examination item	Unite of measurement	Inter-tester Kappa	Inter-tester Gamma
***Standing**			
Symptom in standing	Same, decrease, increase	0.95 (0.80, 1.10)	0 (-0.088, 0.088)
Bilateral shoulder flexion	Same, decrease, increase	0.86 (0.71, 1.01)	0.002 (-0.084, 0.089)
Unilateral Shoulder Flexion	Same, decrease, increase	0.86 (0.71, 1.00)	-0.001 (-0.086, 0.085)
Extension	Same, decrease, increase	0.86 (0.72, 1.01)	-0.007 (-0.089, 0.076)
Flexion	Same, decrease, increase	1 (0.85, 1.14)	-
Rotation	Same, decrease, increase	0.74 (0.59, 0.88)	-0.005 (-0.085, 0.076)
***Sitting**			
Active Neck Rotation	Same, decrease, increase	0.65 (0.51, 0.80)	0 (-0.082, 0.082)
Active Neck Extension	Same, decrease, increase	0.94 (0.79, 1.09)	0 (-0.084, 0.084)
Active Neck flexion	Same, decrease, increase	0.92 (0.78, 1.07)	0 (-0.085, 0.085)
***Supine**			
Active Neck Rotation	Same, decrease, increase	0.95 (0.80, 1.09)	0 (-0.084, 0.084)
***Quadruped**			
Active Neck Rotation	Same, decrease, increase	0.97 (0.82, 1.12)	0 (-0.084, 0.084)
Backward rocking	Same, decrease, increase	0.81 (0.66, 0.95)	0.003 (-0.087, 0.093)
***Muscle Performance**			
Neck Flexors	0/5 - 1/5 - 2/5 - 3/5 - 4/5 - 5/5	0.36 (0.26, 0.46)	0.008 (-0.06, 0.076)
Neck Extensors	0/5 - 1/5 - 2/5 - 3/5 - 4/5 - 5/5	0.49 (0.38, 0.61)	0.005 (-0.062, 0.072)

Diagnosis

The kappa value for reliability between the three testers was good (0.72), and the gamma value was 0.005. Inter-testers reliability in pairs in classification judgments was good. Kappa values are shown in [Table 4]. Results of the 180 classification judgments based on the MSI approach (60 cases× three testers) are tabulated in [Table 5].

Table 4. Inter-tester reliability in classification judgments

Tester's reliability	Kappa value	Gamma value
***Inter-tester three testers**	0.72 (0.58, 0.86)	0.005 (-0.062, 0.072)
***Inter-tester pairs**		
One versus two	0.73 (0.49, 0.97)	-0.058 (-0.237, 0.121)
One versus three	0.73 (0.49, 0.98)	-0.038 (-0.217, 0.14)
Two versus three	0.71 (0.47, 0.94)	-0.019 (-0.196, 0.159)

Table 5. Result of the classification judgments based on the MSI approach (60 cases × 3 testers)

Classification	Frequency	Percent
Ext	3	1.7%
Flex	1	0.6%
Ext-Rot	122	67.8%
Flex-Rot	54	30%

Discussion

The main objective of the current study was to determine the inter-tester reliability of the test items used for the MSI-based classification of patients with neck pain. In addition, it aimed to examine inter-tester reliability for the diagnosis of neck pain categories. We found that the inter-tester reliability was good to excellent for most of the test items. To our knowledge, this is the first study that has been conducted to assess the reliability of the test items and organize reliability for the proposed classification for neck pain problems based on the MSI approach.

In our study, the sign items had poor to excellent inter-tester

reliability (kappa values=0.36-1) [Table 2]. A number of studies have evaluated the inter-testers reliability of MSI classification systems.[18,30,37] Our findings are in line with those reported by Kajbafvala et al. (kappa values=0.18-1) that assessed inter-tester reliability of the physical examination items used for the classification of patients with knee pain.[30] Vandillen et al. conducted a relatively similar study on patients with back pain. Their results showed that inter-tester reliability for the signs was poor to excellent (kappa values=0.00-0.78).[18]

In our study, ten of the symptom items (71% of total symptom items) exhibited excellent inter-tester reliability (kappa values=0.81-1) [Table 3], while four of them showed poor to good reliability (kappa values=0.36-0.74). Vandillen et al. (kappa values=0.87-1) and Kajbafvala et al. (kappa values=0.83-1) showed that inter-tester reliability of all symptom items was excellent.[18,30]

The inter-tester reliability of classification judgment between three testers (kappa value=0.72) and two testers in pairs (kappa values=0.71- 0.73) was good in the current study. Our results were similar to those of Kajbafvala et al., who showed good inter-tester reliability for patient classification judgments in their study (kappa values=0.66 to 0.71).[30] In contrast to our finding, Torwichien et al. investigated the inter-tester reliability of patient classification based on the MSI approach in individuals with shoulder pain and showed poor to acceptable reliability (kappa values 0.20-0.66) for classification judgment.[37] This discrepancy might be attributed to the study design of Torwichien et al., which was different from ours. Low kappa values in this study may be related to symptom changes between two separate examination sessions and the small sample size in the study. The results of classification judgments ranged from 0.6% (neck flexion syndrome) to 67.8% (neck extension-rotation syndrome), which was the most frequent syndrome in this study. McDonnell mentioned neck extension-rotation syndrome as the most common syndrome among her clients.[22] Neck flexion-rotation syndrome took the second rank after neck extension-rotation syndrome. Syndromes with rotation components appeared to be the most prevalent among cervical syndromes. Multi-planar movements are the leading cause of these syndromes. There is an altered distribution of rotation motion across the cervical region and an imbalance of muscle performance among the cervical rotator muscles, with extrinsic muscles contributing to multi-planar movements rather than the precise uniplanar motion. Results are shown in [Table 5].

The current study had some limitations. Firstly, the presence of three testers assessing patients simultaneously might have led to mutual influence among them, particularly during symptom evaluation, where one tester correcting a test could serve as a cue for the other two. Secondly, a larger number of patients were primarily concentrated in two subgroups (flexion-rotation and extension-rotation), which might have resulted in a larger sample size within these categories, potentially skewing the results. Thirdly, patients over the age of 65 were excluded from the study due to concerns about degenerative changes and possible balance or movement disorders associated with aging, limiting the generalizability of the findings to older adults. We recommend that future research explore the reliability of assessments and classifications of neck pain patients between novice and expert testers.

Conclusion

Overall, the inter-tester reliability of test items used for MSI-based classification of patients with neck pain was acceptable. The inter-tester reliability of the classification judgment was good. Accordingly, the MSI approach may be suggested for the examination and classification of patients with mechanical neck pain.

Acknowledgement

N/A

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Declaration of Conflict of Interest: The author(s) do NOT have any potential conflicts of interest for this manuscript.

Declaration of Funding: The source of data used in this paper was from PhD thesis of Mehrnoosh Amin, student of Ahvaz Jundishapur University of Medical Sciences (PhD thesis grant no: PHT-0108)

Declaration of Ethical Approval for Study: The Ethics Committee of the Ahvaz Jundishapur university of medical science (Ethical number: IR.AJUMS.REC.1401.081).

Declaration of Informed Consent: There is no information in the submitted manuscript that can be used to identify patients.

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