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Reliability and validity of modified upper limb neurodynamic tests in patients with cervical radiculopathy

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Background: Neurodynamic Tests (NDTs) are used to assess neural mechanosensitivity in various conditions such as neural sliding, tension or inflammatory dysfunction. But in some upper quadrant dysfunctions, standard testing procedure of NDT cannot be assessed or tolerated by patient.
Objective: The purpose of the study was to determine the validity, intra-rater and inter-rater reliability of modified NDTs via median and ulnar nerve in patients with cervical radiculopathy.
Methods: Thirty-three patients (18 men and 15 women, mean age ± SD -40.18 ± 9.01) with cervical radiculopathy having positive response to standard NDTs were included in the study. Modified neurodynamic tests for median & ulnar nerve were performed with modification in the sequencing of standard neurodynamic test at lower degrees of glenohumeral abduction and external rotation. Outcome measures used were angle of elbow extension for median nerve and angle elbow flexion for ulnar nerve at the point of pain onset indicated by "OP" (Onset of Pain).
Results: Reliability of OP was evaluated using measurement of Intra-class Correlation Coefficient (ICC), Standard Error of Measurement (SEM) and Minimal Detectable Change (MDC) values. Results indicated high ICC values and low SEM values for OP during modified median and modified ulnar NDTs (M-MNT1 and M-UNT) on symptomatic side of patients with cervical radiculopathy. Spearman correlation analysis for validity of test score showed strong correlation ($r = 0.767$) with standard NDT.
Conclusion: There was strong correlation between Modified NDTs and standard tests depicting good validity and substantial reliability of OP during M-MNT1 and M-UNT for positive NDT response in patients with cervical radiculopathy.

Keywords: Cervical radiculopathy; modified upper limb neurodynamic tests; reliability; correlation.

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Introduction

Cervical radiculopathy is a disease of cervical nerve root and most commonly caused by compression of nerve root from herniated cervical disc or inflammation of facet joints or space occupying lesions such as osteophytic encroachment associated with cervical spondylosis.[1] A systematic review that included prevalence studies from several nations of varied geographical area found that the average prevalence for males and females was 1.07 to 1.76 and 0.63 to 5.8 per 1000 people, respectively. Review reported different ranges of prevalence and incidence for cervical radiculopathy with respect to varied population and geographical area. Survey conducted in India in 1991 reported prevalence of 136 per 100,000 population.[2] The diagnosis of radiculopathy is based on the information received during the subjective assessment (history taking) and objective assessment (physical examination). Physical examination includes provocative tests like spurling's test, upper limb neural tension test, valsalva maneuver and neck distraction test for clinical diagnosis of cervical radiculopathy. Previous studies examining diagnostic accuracy of physical tests for diagnosis of cervical radiculopathy shown to have varying degrees of specificity and sensitivity of each test.[3] Hence it is recommended to perform combination of tests to confirm clinical diagnosis.[4,5] Diagnostic imaging such as MRI is considered to confirm the diagnosis and evaluate the severity and level of involvement.[6]

However, the confirmatory diagnosis usually is based on the subjective, objective as well the investigative findings along with the clinical opinion based on the experience of therapist. Traditional special or provocative tests are generally used by clinical therapists to confirm the clinical diagnosis. The number of provocative tests is usually performed to diagnose cervical radiculopathy like cervical compression test or nerve mobility tests or nervous tissue tension tests.

Elvey (1986) was the first who explained upper limb tension tests (ULTT), which involves targeted sequence of movements that provokes symptoms in patients with neural dysfunctions. These tests were further explained by Shacklock in 1996 and Butler in 2000 with sensitivity of 0.97 and specificity of 0.69. According to the neurodynamic solutions concept by Shacklock, these tests are carried out by gradually increasing the tension applied to the nervous system component that is being tested in a sequential manner and then releasing it followed by noting the nature of neurodynamic response and change in response with structural differentiation. The specific limb movements are performed in a particular sequential manner as per the anatomical course of nerve to be tested.[7,8]

According to Michael Shacklock, neurodynamic tests (NDTs) are considered as important predictor of the cervical radiculopathy involving neural dysfunctions like neural sliding dysfunction, neural tension dysfunction, nerve instability or hypermobility and inflammatory dysfunction.[9]

Neurodynamic assessment in patients with cervical radiculopathy is important to gain an impression of the mechanical performance and sensitivity of the neural structures and their related interfacing and innervated tissues. During assessment, specific sequence of movement should be followed to produce specific mechanical changes (like tension, compression, traction, etc.) along the nervous tissues.[9]

Previous studies confirmed that lower cervical spine is commonly involved in cervical radiculopathy where lesion of C7 is most commonly followed by C6, C5, C4 and C8.[10–12] It is recommended to perform NDTs (MNT1 — Median Neurodynamic Test 1, MNT2 — Median Neurodynamic Test 2, RNT — Radial Neurodynamic Test and UNT — Ulnar Neurodynamic Test) to confirm the level of involvement and type of dysfunction in patients with cervical radiculopathy.[9,13] Use of combination of NDTs in cervical radiculopathy increases diagnostic accuracy.[14]

In 2006, a reliability study was conducted by van der Heide *et al.*, to assess the test–retest reliability of modified Neural Tissue Provocation Test (NTPT) via median nerve in patients with cervicobrachial pain syndrome. Such modification was needed in these patients due to limited shoulder abduction range availability required to perform standard testing procedure of ULTT. This study showed that modified NTPT is sufficiently reliable for the clinical use in such patients without following the standard testing procedure of NDT.[15]

Several studies have investigated the normal responses to the NDTs with standard sequencing in patient with cervical radiculopathy.[16–18] However, in some conditions of upper quadrant with increased mechanosensitivity of neural tissues, shoulder abduction and external rotation ROM

may be limited may be due to non-compliance of neural tissue therefore, modification in standard testing procedure was required to assess neural sensitivity using neural tissue tension tests in such circumstances.

In 2010, a study was conducted by Petersen *et al.* to examine intra-rater reliability of radial and ulnar biased neural tissue provocation test in asymptomatic subjects. In their study, a standard sequence described by Elvey was used and at the end of the test, position of elbow (flexion or extension) was measured using electrogoniometer. Results of this study reported that neural tissue provocation test biased toward radial and ulnar nerve can be applied in a reliable fashion on asymptomatic subjects without use of external fixation devices. This study provides a basis for further studies that assess the reliability between sessions and among examiners in a symptomatic population.[19]

In this study, we did modifications in standard tests (median and ulnar biased) described by Michael Shacklock considering the fact that in some conditions of upper quadrant such as capsulitis, shoulder arthroplasty or recent surgery in shoulder region, shoulder abduction and rotation range are limited which restricts the use of standard tests in assessment. To date, no study examined reliability and validity of modified tests sequencing in cervical radiculopathy. So, aim of our study was to determine the validity, intra-rater and inter-rater reliability of modified median and ulnar NDTs in patients with cervical radiculopathy. Study was planned to know whether patients diagnosed with cervical radiculopathy who exhibit a positive response to standard NDTs (median or ulnar biased) also demonstrate abnormal neural response when subjected to NDTs with modified sequencing or lesser degrees of shoulder movements. We hypothesize that the patients with cervical radiculopathy would produce consistent and almost similar neural response (abnormal sensory response and limited range of motion on symptomatic side) to the modified median and ulnar NDT.

Material and Methods

Study design and examiners

This was an intra-rater and inter-rater reliability study. The study was approved by the Institutional Ethical Committee (MGM IOP/IEC/2022-PG/14). While conducting the study, we followed the COSMIN guidelines. Study included three qualified physiotherapists — physios 1, 2 and 3 who had at least 5 years of experience and were trained in performing NDTs.

Intra-rater reliability: To observe intra-rater reliability, four trials — the first being familiarization trial — were performed by physio 1 on same patient with interval of 2 min.

Inter-rater reliability: To observe inter-rater reliability, each patient was assessed for 3 days within the interval of 24 h by different physiotherapists. On first day, first trial was performed by physio 1. On second day, second trial was performed by physio 2 and on third day, third trial was performed by physio 3.

Validity: To measure validity, we had asked six physiotherapy experts who were not involved in the study to rate the modified NDTs on Likert scale:

(1) The test is highly appropriate for the intended purpose.
(2) The test is perfectly suited for given purpose.
(3) The test is sufficient.
(4) The test is deficient.
(5) The test is inappropriate because it is irrelevant.

Subjects

Thirty-seven patients having neck pain radiating to arm (aged 18–60 years) were recruited for the study from Physiotherapy Department of MGM Hospital, Aurangabad (Maharashtra). Subjects who met the eligibility criteria and were willing to participate in the study were screened and written consent was taken.

Sample size calculation was done using Web-based sample size calculator[20] with significance level of 0.05 and a statistical power of 80%. Minimum acceptable reliability (ICC) was set as 0.60 and expected reliability (ICC) as 0.80. Considering 10% dropout rate, total sample of 37 was found to be sufficient. Previous study conducted by Riley *et al.* in 2019 to determine reliability of elbow extension, sensory response and structural differentiation of Upper Limb Tension Test A in healthy population found the ICC values for test–retest and intertester reliability in the range of 0.80–0.87. Considering these values as expected reliability (ICC) sample size was calculated.[21]

Patients were included if they presented with unilateral neck or periscapular pain with radicular pain, paraesthesia or numbness in upper limb, aggrevated by neck movements, duration of symptoms greater than 2 weeks and less than 4 months, having clinical diagnosis of cervical radiculopathy given by Wainner and Gill.[22] Clinical diagnosis criteria was a positive response to at least 3 of the following clinical tests: Spurling's test, NDTs either for MNT1 or UNT must be positive (according to Shacklock's standard sequencing), cervical distraction test and ipsilateral cervical rotation less than 60° on symptomatic side and patients with pain at least 30 mm and less than 80 mm on 100 mm visual analogue scale (VAS). Patients were excluded if they had recent craniocervical trauma including cervical spine fractures, history of neck or arm surgery in last 12 weeks, history of recent shoulder fractures, dislocations or subluxation, unstable neurological signs or disease and cervical myelopathy, pyramidal and extrapyramidal pathology, whiplash injury, osteoporosis, tumor, metabolic disease, resting blood pressure $\geq 149/90$ mmHg, difficulty in lying supine comfortably for particular period of time to perform test, pregnant women, systemic illness such as rheumatoid arthritis.

Out of 37 patients, 4 patients could not complete the study (lost to follow up till third day). Hence totally 33 patients having positive response to one of the NDT (MNT or UNT) completed the study. Seventeen patients who had positive response to MNT1 were included in M-MNT1 group and 16 patients who had positive response to UNT were included in M-UNT group.

Modified test description and procedure

NDTs for both MNT1 and UNT were performed with modification of Shacklock's standard procedure (Table 1) called as Modified Median Neurodynamic Test (M-MNT1) and Modified Ulnar Neurodynamic Tests (M-UNT). Every test was performed on the unaffected arm first then on affected arm. Prior to test performance, patient was explained about the "Onset of Pain (OP)" i.e. point at which patient first produces painful sensory response during the end component of test. Patients were instructed to report the OP during testing.

For M-MNT1

Test was performed with patients in supine lying position without pillow with cervical spine in neutral position. Starting position of upper extremity was arm down by side without rotations, elbow at 90° flexion, wrist and fingers in neutral position. Therapist's hand close to the couch was cupped on the patients test shoulder to prevent shoulder elevation and the therapist's distal hand holds the patient's hand with a pistol grip maintaining the patient's thumb extended. Then sequence of

Table 1. Stepwise sequencing of standard and modified median and ulnar NDTs.

Steps	MNT1	M-MNT1	UNT	M-UNT
Step 1	**Glenohumeral abduction up to 90–110°**	**Glenohumeral abduction up to 45°**	Shoulder depression	Shoulder depression
Step 2	**Glenohumeral external rotation (Usually up to 90°).**	**Minimal glenohumeral external Rotation**	Wrist/finger extension	**Glenohumeral abduction up to 45°**
Step 3	Forearm supination	Forearm supination	Forearm pronation	**Available glenohumeral external rotation**
Step 4	Wrist/finger extension	Wrist/finger extension	Elbow flexion	Wrist/finger extension
Step 5	Elbow extension	Elbow extension	**Glenohumeral external rotation**	Forearm pronation
Step 6	—	—	**Glenohumeral abduction to the limit 90–120°**	Elbow flexion

°*Notes*: MNT1 – Median Neurodynamic Test 1, M-MNT1 – Modified Median Neurodynamic Test 1, M-UNT – Modified Ulnar Neurodynamic Test, UNT – Ulnar Neurodynamic Test.

Fig. 1. Measurement of angle of elbow extension at the end of M-MNT1.

movement followed by therapist was as follows: starting with glenohumeral abduction up to 45°, minimal glenohumeral external rotation, supination of forearm, wrist and finger extension followed by elbow extension (Table 1). Angle of elbow extension was measured (Fig. 1 — End position of M-MNT1) and documented when patient reported OP (onset of pain response).

For M-UNT

Test was performed with patient in supine lying position without pillow with cervical spine in neutral and arm over the edge of couch. Starting position of upper extremity was arm straight and abducted as little as possible, elbow in extension, forearm is somewhat supinated and the wrist and hand in the neutral position. Therapist's hand close to the couch was cupped on the patients test shoulder and the therapist's distal hand holding patient's hand with fingers spread out over the patient's fingers and the therapist's thumb is located behind the patient's metacarpophalangeal joints. Then sequence of movement followed by therapist was as follows: starting with scapular depression, glenohumeral abduction up to 45°, available glenohumeral external rotation, wrist and fingers extension, forearm pronation followed by elbow flexion (Table 1). Angle of elbow flexion was measured (Fig. 2 — End position of M-UNT) and documented when patient reported OP (onset of pain) response.

The reliability of 'OP (Onset of pain)' was tested using the Intra-class Correlation Coefficient (ICC) and Standard Error of Measurement (SEM), with greater ICC and lower SEM values indicating excellent reliability.

Analysis of spearman correlation (r) was used to compare modified test scores to standard tests to test convergent validity.

Fig. 2. Measurement of angle of elbow flexion at the end of M-UNT.

Table 2. The demographic profile of patients with cervical radiculopathy.

No. of patients (n)	33
Gender – Male/Female (No.)	18/15
Age (in years) (Mean ± SD)	40.18 ± 9.01
Duration of symptoms (in weeks) (Mean ± SD)	3.77 ± 1.17

Data analysis

Statistical analysis was done using IBM SPSS statistics 23. For OP (angle elbow flexion or extension score collected at the beginning of pain during the test's last step), Intra-class Correlation Coefficient (ICC (3,1)) values were determined. The standard error of measurement (SEM) was calculated using standard deviation (σ) formula $SEM = \sigma/\sqrt{n}$ described by Will Kenton in 2022. SEM measures the precision of individual scores or the extent that the score varied with repeated measures. A lower SEM is better in that it indicates less variation. Minimal Detectable change (MDC) (95% CI) was determined using steps recommended by Terwee *et al.* in 2007. For convergent validity analysis, spearman correlation coefficient (r) was calculated to correlate scores of modified NDT with standard tests.

Results

All the patients with positive response to the NDTs were included for statistical analysis. Thirty-three patients who had positive response to the modified NDTs (reproduction of abnormal neural response) were included. Descriptive statistics of patients is shown in Table 2. Reliability statistics (ICC, SEM and MDC) for angle of elbow extension and flexion measured during M-NDT are presented in Tables 3 and 4. Mean score for angle elbow extension and flexion measured during three trials are represented in Figs. 3 and 4. Results show high ICC value for OP measured during modified median and ulnar NDTs on symptomatic side of patients with cervical radiculopathy. No significant difference in elbow extension or flexion angle was observed between the three trials performed in patients with cervical radiculopathy which indicates that repeated testing did not significantly alter elbow ROM. ICC values were in the range of 0.77–0.80 and indicates substantial reliability for both median and ulnar biased NDT (0.00 ≥ 0.20 — slight reliability, 0.21 ≥ 0.40 — fair reliability, 0.41 ≥ 0.60 — moderate reliability, 0.61–0.80 — substantial reliability, 0.81 ≥ 1.00 — excellent reliability). SEM values were variable and ranged from 1.40 to 2.18 and indicates low measurement error.

Table 3. Intra-class Correlation Coefficient (ICC) for onset of pain (OP) on symptomatic side – Intra-rater reliability testing.

M- MNT1 group	No. of patients	Mean ± SD	ICC (3,1)	SEM	MDC_{95}
Angle of elbow extension (OP)	17	16.37 ± 5.78	0.80	1.40	5.108
M-UNT group	**No. of patients**	**Mean ± SD**	**ICC (3,1)**	**SEM**	**MDC_{95}**
Angle of elbow flexion (OP)	16	120.37 ± 9.01	0.77	2.18	4.11

Notes: SEM – Standard Error of Measurement, MDC – Minimal Detectable Change.

Table 4. Intra-class Correlation Coefficient (ICC) for onset of pain (OP) on symptomatic side – Interrater reliability testing.

M-MNT1 group	No. of patients	Mean ± SD	ICC (3,1)	SEM	MDC_{95}
Angle of elbow extension (OP)	17	18.7 ± 6.05	0.77	1.46	5.74
M-UNT group	**No. of patients**	**Mean ± SD**	**ICC (3,1)**	**SEM**	**MDC_{95}**
Angle of elbow flexion (OP)	16	121.45 ± 8.87	0.79	2.12	8.03

Notes: SEM – Standard Error of Measurement, MDC – Minimal Detectable Change.

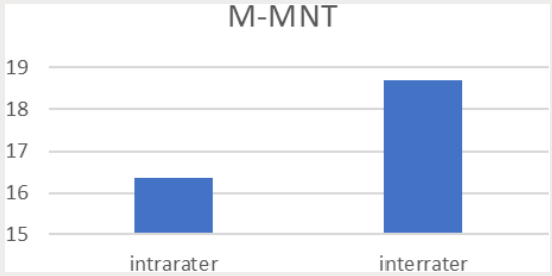

Fig. 3. Mean values of elbow extension at onset of pain on symptomatic side.

The MDC_{95} values were in the range of 4.11° to 8.03° and indicates that assessment of angle of elbow flexion or extension is a sensitive measure. Spearman correlation analysis between standard MNT1 and M-MNT1 shows positive correlation ($r = 0.767$) (Fig. 5) representing good validity of test.

For M-MNT1

The reliability of the M-MNT1 test for measuring the angle of elbow extension at point of pain onset (OP) has ICC value of 0.80, indicates substantial intra-rater reliability of the modified test. Additionally, a low SEM value of 1.40 suggests that the test exhibits minimal measurement error and higher precision. MDC_{95} of 5.108 signifies that the measurement of angle of elbow extension is sensitive measure (smaller the value of MDC_{95}, the more sensitive the measure).

For M-UNT

The reliability of the M-UNT test for measuring the angle of elbow flexion at point of pain onset (OP) has ICC value of 0.77, indicates substantial intra-rater reliability of the modified test. Additionally, a low SEM value of 2.18 suggests that the test exhibits minimal measurement error and higher precision. MDC_{95} of 4.11 signifies that the measurement of angle of elbow flexion is sensitive measure (smaller the value of MDC_{95}, the more sensitive the measure).

For M-MNT1

The reliability of the M-MNT1 test for measuring the angle of elbow extension at point of pain onset (OP) has ICC value of 0.77, indicates substantial

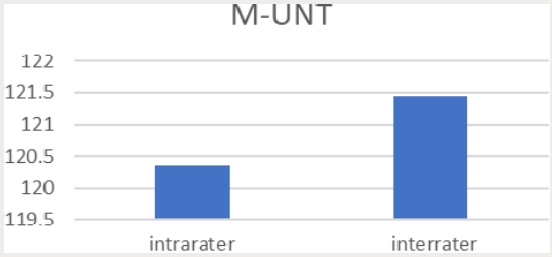

Fig. 4. Mean values of elbow flexion at onset of pain on symptomatic side.

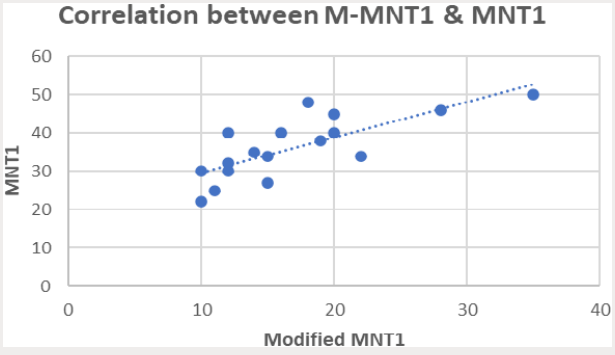

Fig. 5. Correlation between angle of elbow extension (OP) of MNT1 versus Modified MNT1.

inter-rater reliability of the modified test. Additionally, a low SEM value of 1.46 suggests that the test exhibits minimal measurement error and higher precision. MDC_{95} of 5.74 signifies that the measurement of angle of elbow extension is sensitive measure (smaller the value of MDC_{95}, the more sensitive the measure).

For M-UNT

The reliability of the M-UNT test for measuring the angle of elbow flexion at point of pain onset (OP) has ICC value of 0.79, indicates substantial inter-rater reliability of the modified test. Additionally, a low SEM value of 2.12 suggests that the test exhibits minimal measurement error and higher precision. MDC_{95} of 8.03 signifies that the measurement of angle of elbow flexion is sensitive measure (smaller the value of MDC_{95}, the more sensitive the measure).

When scores of 'OP' (angle of elbow extension at the point of pain onset) of modified MNT1 were corelated with score of standard MNT1 strong correlation ($r = 0.767$) was found.

Discussion

The purpose of this study was to determine reliability and validity of median and ulnar NDTs with changes in sequence or degrees of shoulder movements. We found the tests to be reliable and valid with a small measurement error and strong correlation with scores of standard NDT. The results of the study shows that the reliability of detection of Onset of pain response (OP) with modified version of upper limb NDT via median and ulnar nerve was sufficient for clinical assessment of neural sensitivity as indicated by an ICC value in the range of 0.77–0.80 on symptomatic side of patients with cervical radiculopathy. The lowest SEM (1.40° to 2.18°) and high ICC values produced in this study indicates substantial reliability for both M-MNT1 and M-UNT with minimum measurement error. So, modified version of MNT and UNT can be used for assessment of neural tissue mobility where standard neural testing procedure is not advisable or not achievable. Although pain is a subjective measure, our results justify the detection of Onset of Pain which is an objective measure to predict positive neural response to the M-MNT1 and M-UNT. Universal goniometer was used for the detection of Onset of Pain response (angle of elbow extension or flexion at point of pain onset).

Universal goniometer was used by a single therapist for the measurement of OP (angle of elbow extension or flexion at the onset of pain) to maintain (as much as possible) an appropriate level of accuracy during NDT performance and data collection. The time interval between two consecutive NDT was decided to 2 min to return nerve to the pre-response level and to improve the tolerance of patient during subsequent trials. For inter-rater reliability testing, the time period between two different data collection sessions was set to 24 h for all the three assessors (physios 1, 2 and 3).

The minimal detectable difference (MDD) suggests that clinicians will need to see a change of between 4° and 9° in the end range elbow position on repeated measures of the NDT in order to conclude true change has occurred. Differences upon reassessment of less than MDC value (4°) could be attributed to measurement error.

Though difference in range of motion between symptomatic and asymptomatic sides with pain response and type of pain response is clinically significant measure during assessment of ULNT, in this study angle of elbow flexion or extension at the level of pain onset (OP) was considered for assessment rather than difference in ROM between symptomatic and asymptomatic side which is also found to be reliable.[23]

Five out of six experienced physiotherapists rated M-MNT1 and M-UNT tests as highly appropriate or extremely suitable for the purpose of neurodynamic assessment on five-point Likert scale mentioned in methods. During test performance, modified version of MNT1 and UNT produced similar and consistent response to that of standard NDTs that supports the face validity of testing procedure evaluated in this study as compared to normal version of neurodynamic test. It suggests that modified version of NDTs described in this study is means to deliver mechanical stimulus to neural tissue to elicit the expected neural response.

Results of correlation analysis showed strong ($r = 0.767$) relationship between modified MNT1 and standard MNT1. As the construct of standard and modified UNT was different, correlation analysis for UNT was not possible. But clinically M-UNT reproduced almost similar response like standard UNT suggesting that M-UNT also determines neural sensitivity by providing tension to neural component.

In our study, patients with cervical radiculopathy who had positive response to standard

ULNT for median or ulnar nerve also reproduced an almost similar neural response to the modified NDTs. Similarly, Van der Heide *et al.* have reported the excellent test–retest reliability and face validity of Modified Neural Tissue Provocation test for median nerve (shoulder abduction was performed to available degrees with elbow extension as end component) in patients with cervicobrachial pain syndrome. Their results also showed that $P1$ (angle of elbow extension at the level of pain threshold) and $P2$ (angle of elbow extension at the level of pain tolerance) were sufficiently reliable for clinical assessment in patients with cervicobrachial pain syndrome in which the shoulder abduction is usually limited.[15]

Riley *et al.* in 2019 conducted study to investigate inter-rater and test–retest reliability of degrees of end range elbow extension and structural differentiation of Upper Limb Tension Test A (ULLT A) in healthy asymptomatic population. Elbow extension was performed as end component followed by structural differentiation (contralateral and ipsilateral cervical bending). Angle of elbow extension was measured using universal goniometer when patient first time reported sensory response (SR1) or when maximal resistance was felt by therapist (R2). Study results demonstrated that elbow extension is reliable to assess during ULTT A. Results of this study cannot be generalized to symptomatic population as this study was performed on healthy, asymptomatic population.[21]

Taher *et al.* in 2022 found no significant difference between average measurement of elbow joint extension angle (median and radial nerve testing) and shoulder joint abduction angle (ulnar nerve testing) taken between onset of stretching pain and submaximal pain in one session and between two sessions in asymptomatic subjects.[24] Results of their study found to have substantial to excellent reliability for all three nerves.

Similarly, our study considered angle of elbow at the onset of abnormal pain response while M-MNT1 and M-UNT showed substantial reliability in patients with cervical radiculopathy.

One of the limitations of this study is that the difference in angle of elbow flexion or extension between the symptomatic and asymptomatic sides was not taken into consideration for the interpretation of positive response while considering this criterion might vary the results. Another limitation is that correlation analysis between standard UNT and Modified UNT was not possible as the outcome measures used in this study was different from the standard test. Future studies should focus on further validation of modified Median Neurodynamic test 1 and Modified Ulnar Neurodynamic test. Similar reliability studies of modified NDTs should be carried out in other peripheral neuropathic pain conditions of upper limb.

Clinical Implication

Modified Median Neurodynamic Test (M-MNT1) and Modified Ulnar Neurodynamic Test (M-UNT) can be used as alternative to the standard MNT1 and UNT for the assessment of neural tissue mobility/mechanosensitivity especially in conditions where standard testing procedure is not achievable.

Conclusion

The modified upper limb NDTs indicated by OP (onset of pain) at specific angle of elbow extension during MNT1 and elbow flexion during UNT have substantial reliability and validity for positive NDT response in patients with cervical radiculopathy. Modified NDTs are recommended during clinical examination for the diagnosis of cervical nerve root related pathologies.

Conflict of Interests

The authors have no conflicts of interest relevant to this research paper.

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Author Contributions

Conception and design of study was made by S. Wani; acquisition of data was made by R. Zanwar; analysis and interpretation of data were made by S. Wani and R. Zanwar; drafting the paper was made by S. Wani; statistical analysis was made by S. Wani and R. Zanwar; revising the paper critically for important intellectual content was made by S. Wani. All authors were involved in the approval of the paper to be published.

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