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# Finding Baseline Parameters Of The Neurodynamic Test of The Upper And Lower Limbs: False Positive Rate Among Healthy Asymptomatic Adult

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## ABSTRACT

***Background:*** Neurodynamic tests are used by most physiotherapists in clinical examinations to differentiate the underlying pathoanatomic structures. We examined the false positive rate of upper limb neural tension test (ULTT) & seated slump test (STT) in healthy individuals with no history of any cervical & lumbar symptoms. To form baseline parameters to differentiate between normal and actual pathology.

***Methods:*** An observational cross-sectional study. Ninety-eight subjects participated, with 49 males & 49-female with mean ages of twenty-two 22.28 & 20.53 respectively. The test methods used were ULTT and SST. Tester 1 performed the test. Tester 2 was blinded & measured the range of motion employing universal goniometry.

***Results:*** The mean elbow extension for ULTT-R was 32.67 with 95% C. I between 30.38° to 34. 89°. And for ULTT-L, it was 34.75° with a 95% CI between 32.61 to 36.89. The mean knee extension for SST-R was 15.92° with 95% C. I between 12.81 to 19.03. And SST-L was 14.27 with 95 % C. I was between 11.51 to 17.04. To increase ULTT and SST's diagnostic accuracy, clinicians can use these results to establish baseline criteria for identifying pathological and non-pathological findings.

***Conclusion:*** Based on the 75th Percentile, we suggested that a positive test only be identified when peripheral symptoms are reproduced before 20° of knee extension on the right and 18° on the left side and elbow extension before 45° on the right and 41° on the left side.

***Keywords:*** Physical examination, Range of motion, upper limb neural tension test, Seated slump test.

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## INTRODUCTION

According to Shacklock, neurodynamic is a term that refers to the integrated biomechanical, physiological, and morphological functions of the nervous system. The nervous system must adapt to mechanical loads and tolerate various dynamic movements such as sliding, elongation, and compression [1]. Butler defined the nervous system as a whole as a continuous structure that slides constantly when we move, and this movement is linked to essential physiological functions, including blood flow to neurons [2]. Neurodynamics offers a fresh understanding and management strategies for common syndromes such as plantar fasciitis, tennis elbow, nerve root disorders, carpal tunnel syndromes, and spinal pain [3]. Most physical therapists and other health care providers use neurodynamic tests (neural tension tests) in clinical examination to differentiate the underlying patho-anatomic structures [4]. The straight leg raises (SLR), seated slump test (SST), and upper limb neural tension test are the most popular neurological tests (ULNTT) [5]. ULTT and SST procedures are used to determine adverse mechanical tension in the neural system of the upper limb and lower limb. It plays a significant role in several musculoskeletal conditions ADDIN [6]. The most widely used ULNTT is (ULNTT1), which accentuates strain on the median nerve. SST will be used to assess the sensitivity of neural structures such as meningeal tissues, nerve roots, and the sciatic and tibial nerves [7].

A musculoskeletal reaction remains unchanged during structural differentiation, according to Shacklock, whereas a neurodynamic behavior occurs when symptoms, range of motion, or resistance to movement vary [1]. Also, he suggested that an abnormal neurodynamic response requires positive structural differentiation and reproduction of the patient's symptoms. It should be highlighted that in asymptomatic people, reproducing symptoms is impossible (no pathology). It has been established earlier that positive symptoms can be reproduced even in asymptomatic subjects, so the credibility of neurodynamics test is questioned; thus, this study has been conducted to determine the false positive rate of ULTT and SST among healthy young adults in an Indian population; since most of the earlier researchers, has been performed in the western population. There is also a shortage of literature comparing ULTT and SST bilaterally. No study was done on healthy asymptomatic individuals to determine the false positive rate of ULTT and SST in an Indian population. Finding a cutoff score to differentiate between a false positive test and true abnormal pathology is essential. Further, it intends to determine whether any differences exist between dominant and non-dominant sides.

## METHODS

### 2.1. Study design

An observational cross-sectional study evaluated the false positive rate of the upper limb neural tension test (ULNTT) and seated slump test (SST) among the Indian population. This study was conducted at the Mahatma Gandhi Mission School of Physiotherapy, Aurangabad. Asymptomatic participants were recruited from the same institute where the study was conducted. The study procedure was initiated after the approval of MGM's Ethics Committee for research on human subjects (MGM-ECRHS/2020/2). Consent was obtained from all participants before they were enrolled in the study.

### 2.2. Participants and requirement

There were 98 healthy adult participants (49 -male and 49-female). People between the ages of 17 and 30 were invited to take part in this experiment. The participants were drawn from different sources from Aurangabad to minimize possible bias due to activity levels or occupation by purposive sampling. The test methods used were ULTT and SST.

Inclusion criteria were 1) Age (17-30years), 2) Healthy asymptomatic individual, male or female, 3) normal sensory responses in upper and lower limbs, 4) normal pain-free and full range of motion- (a) Elbow extension, wrist flexion/extension, or finger flexion/extension, cervical spine quadrant movements, glenohumeral abduction, and hand behind back, elbow extension, wrist flexion/extension, or finger flexion/extension (b) Movements of thoracic spine, lumbar spine, hip flexion, knee extension and ankle dorsiflexion.

Exclusion criteria were 1) any medical red flags (Tumor, Fracture, Metabolic disease, rheumatoid arthritis, Osteoporosis, prolonged history of steroid use), 2) Bilateral upper extremity symptoms, 3) evidence of CNS involvement, 4) if participants had any history of upper and lower extremity pain, 5) If participants had any central or peripheral nervous system disease.

### 2.3. Blinding

Tester 1 performed the test. Tester 2 measured the range of motion using a universal goniometer and was blinded to the study.

### 2.4. Instruments used

Instruments used for the study: 1) Universal goniometer to measure the range of motion of the elbow extension and knee extension; 2) Body chart – to record the sensory response in the body while performing the tests.

### 2.4. Procedure

a) Upper Limb Tension Test: The investigator explained the ULNTT to each participant before the test. Each participant was positioned supine on the examination plinth. The investigator moves the left upper limb and cervical spine passively. A firm end-feel was felt by passively flexing the cervical spine to the right, away from the investigated upper extremity. Additionally, passive lateral flexion was used [8]. With the elbow in 90 -degrees of flexion, the glenohumeral joint was externally rotated 90 -degrees in Figure 1. The wrist, fingers, and thumb were passively extended, while the forearm was supinated. The arm was stretched until the individual reported the beginning of neural-mediated symptoms or until full elbow extension was obtained.

To determine structural distinction, if symptoms appear before full elbow extension, then the subject's cervical spine was placed at neutral [9-13].

**Figure 1: Procedure for ULTT1**

b) Seated Slump Test: The individual was seated in an upright position. The individual was instructed to take a slouched position. After that, the individual was requested to bend the cervical spine gently as far as was comfortable. The upper thoracic and lower cervical spines were then gently over-pressured by one investigator, who maintained the individual in this posture throughout the investigation in Figure 2. The left ankle was passively dorsiflexed, while the knee was passively stretched. The knee was raised until the individual reported the onset of neural-mediated symptoms or until full knee extension was obtained. If the subject suffered neurological symptoms while extending their knees, the action was stopped, and the individual was told to actively perform cervical spine extension to identify any structural distinction [14-16].

**Figure 2: Procedure for SST**

## RESULTS

All the data were analyzed using SPSS statistical software. The percentage of positive test results divided by the total sample size was used to determine each test's false positive rate. A total of 98 subjects participated in this study, 49 males (50%), with a mean age of 22.28, a standard deviation of 2.95, and a range between 18 and 30. And 49 females (50%), with a mean of 20.53 and SD of 1.98, range between 17 and 24, participated in this study; 95 participants were right-handed (47 males and 48 females) & 3 participants were left-hand dominant (two males and one female).

The percentage of false positive rates of ULTT on the right side was 90.8%, and on the left was 91.8%. For SST, the right side was 81.6%, and the left was 82.6%. The percentage of false positive rates for ULTT in males was 89.79%, and for SST, it was 79.59%. The value for ULTT in females was 93.87%, and for SST, it was 87.75%. For each test, Table 1.1 contains descriptive statistics such as the mean, range, standard deviation, 95 percent confidence interval, and 75th percentiles. Table 1.2 shows the distribution of sex according to dominant and non-dominant sites. A chi-square statistic was performed to see if there was a significant difference between the right and left extremities. There was no significant difference between the dominant side (P= 0.317) for both ULTT and SST (Note if $p>0.05$ is not significant, if $p<0.05$ significant). Kappa statistics table 1.3 revealed substantial agreement between ULTT-R & SST-R methods for positive results (p=0.605). And moderate agreement between two ULTT- L & SST-L methods for positive results (p=0.59).

Table 1.4 shows the comparison between ULTT-R vs.ULTT-L and SST-R vs. SST-L. The ULTT-R had 89 positive tests with a mean of 32.67& SD- 10.12. For the ULTT-L, there were 90 positive tests with a mean of 34.75 & SD- 9.62. For the SST-R, there were 80 positive tests with a mean of 15.92 & SD of 13.77. There were 81 positive tests for the SST-L with a mean of 14.27 & SD – 12.42. The mean elbow extension for Right side-positive ULTT was 32.67°with 95% C.I between 30.38° to 34.89° & 75$^{th}$ percentile was 45°.

The mean elbow extension for left side-positive ULTT was 34.75° with 95% CI between 32.61°to 36.89°& 75$^{th}$ Percentile was 41°. The mean knee extension for Right side-positive SST was 15.92° with 95% CI between 12.81°to 19.03°& 75$^{th}$ Percentile was 20°. The mean knee extension for left side-positive SST was 14.27 with 95% CI between 11.51°at 17.04°& 75$^{th}$ Percentile was 18°.

## DISCUSSION

Pain-sensitive structures, particularly those containing nociceptive structures, will likely produce unwanted symptomatic reactions if enough deforming force is applied [17-20]. As a result, it's not surprising that stretching a nerve or nerve root to its anatomical limit causes unwanted neural-mediated responses. Synovial vertebral nerve innervates the dura mater, while myelinated nervi nervorum fibers in the epineurium are believed to innervate peripheral nerves intrinsically [21-22]. Neurogenic pain is strongly associated with nervi nervorum fibers; this study aimed to find a suitable range of motion cutoff scores and help distinguish between normal and pathologic neural strain, knee and elbow extension, and bilateral comparison and reproduction of the patient's complaints. In this study,

we discovered that the SST right side had a false positive rate of 81.6 percent and the SST left side had a false positive rate of 82.6 percent. Every positive test was considered a false positive because the participants were found to be asymptomatic. The mean SST knee extension measurement for those who participated in the study was 15.92 -degrees on the right side and 14.27 -degrees on the left side. Many studies showing the influences of different components of joint movements may vary the findings in neural tissue provocation tests; some suggested SST, knee extension, and ankle dorsiflexion can be taken as a terminal movement to elicit the response [23-25].

D. Scott Davis et al. 2013 conducted a study in a sample of 54 subjects who reported a knee extension angle of 15%. However, they had not taken bilateral measurements [26]. The false favorable rates in this investigation do not support the abovementioned study. According to the researchers, the SST had a 33.3 percent false positive rate. We propose that the theoretical upper limit for interpreting a positive test be increased to 20 -degrees for the right and 18 degrees for the left, based on the findings of this study. It is the upper limit of the 75th Percentile. The mean for elbow flexion in this study on the right side was 32.67 -degrees; on the left, it was 34.75 degrees, a little lower than that obtained by D. Scott Davis et al., as 49.4 degrees. We proposed 45 degrees of elbow flexion on the left side as a suitable cutoff score for interpreting a positive ULNTT based on the findings of this study. Although it looks arbitrary, the 75th Percentile is used as a cutoff score to reduce the number of false positive tests to a clinically acceptable level. Validation of these cut-off scores in healthy persons and diseased circumstances will require more research. In addition to the previous points, it is vital to highlight the strengths of the present study and defend its validity. Firstly, the present study included a sufficient sample size of subjects, enhancing the findings' generalizability to the population of interest. A larger sample size reduces the likelihood of chance findings and provides more reliable results.

Moreover, the present study addressed a limitation of the study conducted by Davis et al., as bilateral measurements were considered. This approach provides a more comprehensive assessment of the knee extension angle and contributes a more accurate understanding of the measurements. Furthermore, the present study's findings regarding false favorable rates in the Straight Leg Raise test and the ULTT were consistent with the results reported by Davis et al. This consistency suggests the reliability of the current study's methodology and strengthens its credibility.

The proposed cut-off scores for interpreting a positive test, based on the present study's findings, offer valuable clinical guidance. Setting these cut-off scores aims to minimize the number of false positive tests to a clinically acceptable level. This approach is essential to ensure accurate diagnosis and appropriate patient treatment decisions.

It is also crucial to emphasize the clinical reasoning behind the proposed cut-off scores. The decision to use the 75th Percentile as the cut-off is based on considering clinical relevance and practicality. This approach accounts for the natural variation in individual measurements and identifies thresholds more likely to indicate valid positive results. By setting the cut-off scores within the 75th Percentile, the current study aims to strike a balance between sensitivity and specificity, optimizing the diagnostic accuracy of the tests.

These proposed cutoff scores are for an Indian population. Further, comparing the dominant and non-dominant sides using the chi-square, there was no significant difference between the dominant and the non-dominant sides. Structural differentiation alleviates all symptoms in individuals with a positive SST or ULNTT. As a result, tension on neural tissue rather than musculoskeletal structures is assumed to be the origin of the symptoms. Benjamin S Boyd and Philip S Villa in 2012 concluded that the overall range of motion during SLR was related to sex, weight, BMI, and activity level, which is likely reflected in the high variability and 95% confidence that inter-limb differences during SLR neurodynamic testing fall below 11 -degrees in 90% of the general population of healthy individuals.

Furthermore, demographic factors did not affect inter-limb differences and thus may be a more valuable comparison for test interpretation [27]. Our study found the agreement between the SST-R and ULNTT-R; the kappa statistics showed a substantial agreement (K=0.605) and a moderate agreement between ULNTT-L and SST-L (k=0.59). Notably, most of those with a positive SST also had a positive ULNTT. It is also interesting to note that both SST and ULNTT had higher values for cutoff on the right side than the left, i.e., symptoms were caused earlier on the right side than on the left side. The reason is that most of the individual's right side is more dominant and can lead to symptoms at an earlier angle of elbow extension and flexion. Also, compared to the Western population, we have a higher false positive rate for ULNTT and SST. It can be attributed to the fact that Indians lead a more sedentary lifestyle, and physical fitness is not a part of our daily routine. Thus, the flexibility is reduced, leading to all other neuro-musculoskeletal problems.

### 4.1 Clinical significance

Physical therapists and clinicians can use these findings to establish baseline parameters or a cut-off score for distinguishing between pathological and non-pathological findings. Additionally, it can be a more helpful baseline evaluation measurement before deciding on a treatment plan.

## CONCLUSION

When full-range testing is performed on healthy persons without a history of spinal or peripheral complaints, there is a large amount of intrinsic neural sensitivity. We have presented a proposed cutoff score to improve the diagnostic accuracy of ULTT and SST. As a result, a positive test can only be determined whether peripheral

symptoms are replicated on the right side before 20 degrees of knee extension and 18 degrees on the left side, and elbow extension before 45 degrees on the right side and 41 degrees on the left side, based on the 75th Percentile.

**Tables:**

| Parameter | Mean | Standard Deviation | Range | CI 95% | 75% Percentile |
|---|---|---|---|---|---|
| ULTT R | 32.67 | 10.12 | 12 to 62 | 30.38 to34.89 | 45 |
| ULTT L | 34.75 | 19.62 | 14 to 63 | 32.61 to 36.89 | 41 |
| SST R | 15.92 | 13.77 | 0 to 65 | 12.81to 19.03 | 20 |
| SST L | 14.27 | 12.42 | 0 to 64 | 11.51 to 17.04 | 18 |

**Table1.1: Descriptive statistics of ULTT and SST Tests**

| Sex | Dominant side | | Total | $X^2$ value | p-value | Inference |
|---|---|---|---|---|---|---|
| | Right | Left | | | | |
| Male | 47 | 02 | 49 | 1 | 0.317 | Non-Significant |
| Female | 48 | 01 | 49 | | | |
| Total | 95 | 03 | 98 | | | |

**Table1.2: Distribution of sex according to dominant and non-dominant sites**

| KAPPA agreement | | ULTT- R | | Total |
|---|---|---|---|---|
| | | Positive ( +) | Negative (-) | |
| SST – R | Positive ( +) | 79 | 01 | 80 |
| | Negative (-) | 10 | 08 | 18 |
| Total | | 89 | 09 | 98 |
| KAPPA agreement Positive ( +) | | ULTT- R | | Total |
| | | Negative (-) | | |
| SST –L | Positive ( +) | 80 | 01 | 81 |
| | Negative (-) | 10 | 07 | 17 |
| Total | | 90 | 08 | 98 |

**Table1.3: Kappa statistics between ULTT-R and SST-R; (Kappa =0.605) & Kappa statistic between ULTT-L and SST-L; (Kappa=0.59)**

| Tests | t-value | p-value | Inference |
|---|---|---|---|
| ULTT-R vs. ULTT-L | 0.950 | 0.345 | NS |
| SST-R vs. SST-L | 4.39 | 0.004 | S |

**Table1.4: comparison between ULTT-R vs.ULTT-L and SST-R vs. SST-L**

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