



“Effect of 9 Hole Peg-Board Test for Improving Hand Dexterity Among Tuberculosis Patients”

^{1*}Dr. Ankita Saxena, ²Sudherm Jain, ²Tahura Munif, ²Devansh Rai, ²Ritu Raj, ²Ayush Shukla

^{1*} Assistant Professor, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, U.P.

² BPT Final Year, Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, U.P.

(Received: 04 February 2024

Revised: 11 March 2024

Accepted: 08 April 2024)

KEYWORDS

Tuberculosis, 9
Hole Peg board,
Hand dexterity

ABSTRACT:

Objectives: To check the effect of 9-Hole Peg Board Test for improving Hand dexterity among Tuberculosis patients.

Methods: A total of 120 subjects were chosen as per inclusion and exclusion criteria via convenient sampling method. Subjects who were diagnosed with Tuberculosis were recruited in the study between Age group 20-70 years.

Subjects were asked to fill the assessment form and were asked to perform the 9Hole Peg Board Test from Dominant and Non Dominant hands. The data was recorded continuously for 2 days to check any improvement in the performance of the patients and the net score was calculated.

Result: The result was calculated by using the independent T-test. Significant and non-significant result came out as per variables.

Conclusion: The present study proves that there is a significant effect of 9 Hole Peg Board testing on Dominant hand as well as on Non-dominant hand whereas if comparison is done between dominant and non-dominant hand, significant effect is seen maximally on dominant hand.

Introduction

Tuberculosis (TB) is an ancient disease that has affected mankind for more than 4,000years ⁽¹⁾. A chronic disease caused by the bacillus Mycobacterium tuberculosis that spreads from person to person through air.

TB affects the lungs but it can also affect other parts of the body, such as brain, intestines, kidneys and spine. Symptoms of TB depend on where in the body, the TB bacteria is growing. In the cases of pulmonary TB, it can cause symptoms, such as chronic cough, pain in the chest, hemoptysis, weakness or fatigue, weight loss, fever, and night-sweats.

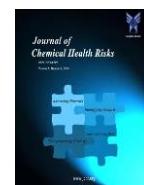
TB is the most common cause of death from a single source of infection among adults ⁽²⁾ It is the first infectious disease declared by the World Health Organization (WHO) as a global health emergency⁽³⁾. TB has other symptoms which leads to severe infections

further causing neuropathies and nephropathies.⁽⁴⁾

Peripheral neuropathy (PN) is a severe condition that affects the nerves that is commonly seen in patients with tuberculosis (TB). There are a number of factors that can lead to damage of the peripheral nerves and the development of neuropathy, including TB itself, other co-morbid conditions like HIV, Diabetes Mellitus (DM), and the medications used to treat Tuberculosis like isoniazid (INH), linezolid, vitamin B group may lead to neuropathy in tuberculosis patients⁽⁴⁾

Neuropathy occurs in patients with tuberculosis for a number of different reasons. Some of the reasons according to the study are alcohol, malnutrition and medication effect and tuberculous meningitis can be the reason⁽⁵⁾

Neuropathy may lead to granulations formation which lead to the changes in hand dexterity and affects the



cognition of TB patients.

The 9-HOLE PEG BOARD TEST is a quantitative measure of upper extremity (arm and hand) function. Its use with Multiple Sclerosis patients was first reported by Goodkin, Hertsgaard, & Seminary in 1988⁽⁶⁾

The 9-Hole Peg Test is mostly repetitively used manual measure for dexterity. Test involves putting and removing the pegs one by one using only one hand as fast as possible in to and out of the holes.

The 9-Hole Peg Test is an inexpensive apparatus that is not time intensive. According to various studies, 9- Hole peg test is excellent test to measure the dexterity in various diseases and impairments. ⁽⁷⁾

Methodology

Current study was an experimental study and the selection criteria was convenient sampling. The data was taken from TB ward of TMU Hospital, Moradabad. Data was also collected from other hospitals present in nearby villages like District Hospital, Noorpur and Aproula.

Written informed consent was taken from each subject.

Inclusion Criteria-

- Age group 20-70 years
- Both the genders
- Subjects who were TB positive

Exclusion Criteria-

- Patients suffering from any severe cardiovascular, neurological and musculoskeletal condition due to which their normal daily activity was affected.
- Patients with Drug Resistance TB are being excluded
- Unconscious patients
- Patients on Ventilator
- Non-cooperative patients

Instrumentation-

- 9-Hole Peg board
- Stopwatch

Procedure

The randomized study was performed on 120 subjects

having Tuberculosis infection and who were TB positive on documentation. Samples were taken through convenience sampling method. The subjects were asked to pick the peg from the side of the board and stopwatch was started. The subject was instructed to be as quick as he can while performing the task.

The Nine Hole Peg Test was conducted with the dominant arm first. One practice trial (per arm) was provided prior to timing the test.

Timing was recorded with a stopwatch (in seconds). The stopwatch was started when the patient touched the first peg. The stopwatch was stopped when the patient placed the last peg in the Board. The reading was taken through both dominant and non-dominant hands.

The Data was recorded continuously for 2 days to check any improvement in the performance of the patient.

Results

The final analysis included complete data set of 120 participants. Measurement of both dominant and non-dominant hands was taken. Data was collected continuously for 2 days and readings were taken.

Among 120 subjects, 93 were males and 27 were females. 102 subjects were right-handed and 18 subjects were left-handed in dominant hand category. 18 subjects were right-handed and 102 subjects were left handed in non-dominant hand category.

Comparison of Dominant & Non-dominant hand was done by using **Paired t test**. (P value of dominant hand was 0.036 and P value of non-dominant hand was 0.661). The result was calculated by using **Pearson's correlation coefficient test**

The result came out as:

“Table 1: Correlation of 9HPB with Dominant hand (Day 1 and Day 2)”

9HPB Reading in Sec.	Dominant Hand Day 2	P-value*
Dominant Hand Day 1	0.948	0.001

Table 1 shows that correlation between Day 1 and Day 2 of 9 Hole Peg Board with Dominant hand was



significant with $r=0.948$. There was highly significant correlation between the readings of both days.

“Figure 1: Correlation of 9HPB with Dominant hand (Day 1 and Day 2)”

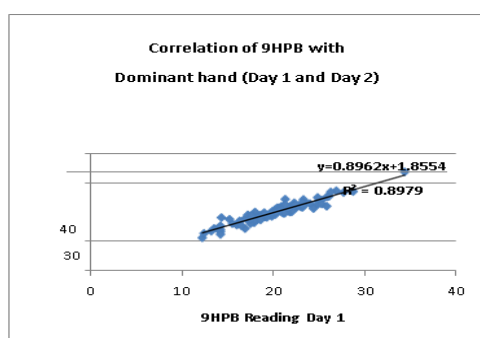


Figure 1 shows that correlation between Day 1 and Day 2 of 9 Hole Peg Board with Dominant hand was significant with $r=0.948$. There was highly significant correlation between the readings of both days.

“Table 2: Correlation of 9HPB with Non-dominant hand (Day1 and Day2)”

9HPB Reading in Sec.	Non Dominant Hand Day 2	P-value
Non Dominant Hand Day 1	0.933	0.001

Table 2 shows that correlation between Day 1 and Day 2 of 9 Hole Peg Board with Non-dominant hand was significant with $r=0.933$. There was highly significant correlation between the readings of both days.

“Figure 2: Correlation of 9HPB with Non-dominant hand (Day1 and Day2)”

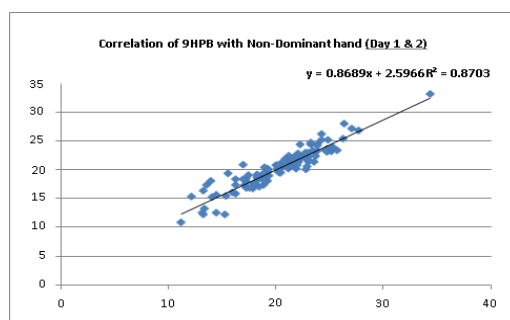
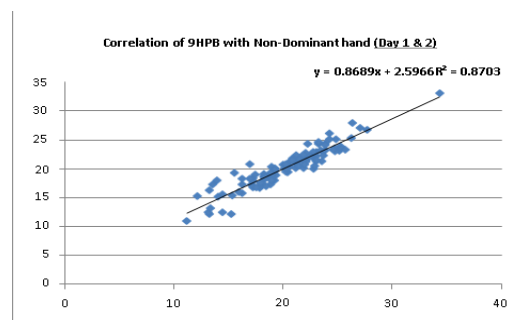


Figure 2 shows that correlation between Day 1 and Day

2 of 9 Hole Peg Board with Non-dominant hand was significant with $r=0.933$. There was highly significant correlation between the readings of both days.



“Table 3: Comparison between Day 1 and Day 2 of Dominant and Non- dominant hand”

Hand	Day1 (Mean SD)	Day2 (Mean SD)	P-value*
Dominant	20.041 3.618	19.816 3.422	0.036
Non Dominant	20.208 3.679	20.155 3.427	0.661

Table 3 shows that comparison between Day 1 and Day 2 9HPB reading of dominant and non-dominant hand. It was significant for dominant hand with $P=0.036$ and was non-significant for non-dominant hand with $P=0.661$.

“Figure 3: Comparison between Day 1 and Day 2 of Dominant and Non- dominant hand”

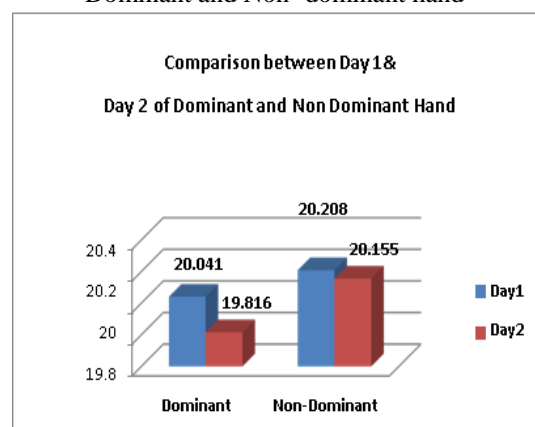


Figure 3 shows that comparison between Day 1 and Day 2 9HPB reading of dominant and non-dominant hand. It



was significant for dominant hand with $P=0.036$ and was non-significant for non-dominant hand with $P=0.661$.

Discussion

The present study proves that Nine Hole Peg Board test is used to measure the dexterity in patients with Tuberculosis. It is an instrument that was developed to measure finger dexterity for the assessment of fine manual dexterity. It was originally introduced by Kelloral⁸

De los Reyes Guzmán A et al In 2012 stated that Nine Hole Peg test is one of the main manipulative skill assessment instruments that offers information on motor aspects and provides levels of strategies that affect the functionality of the subjects' hands in a positive way.⁹

Peripheral Neuropathy in TB is due to immune mediated mechanisms and there are many other reasons but mostly there is granuloma formation in the nerves which was stated by Stefan Ehlers - et al in 2012¹⁰

The rate of Peripheral neuropathy in general population is 1.1% and 6% in elder population according to this study done by G Devigili et al in 2008

Y.A. Smith et al in January 2000 did a study which evaluated norms for fine motor dexterity skills on school age children and conducted the validity and reliability study on 9-Hole peg board test and found the more effect on fine motor dexterity in evidence of 9-hole peg board¹¹

Sanil John, et al in 2017 evaluated the hand function in healthy individuals and in patients with cervical spondylotic myelopathy (CSM) undergoing central corpectomy using the nine-hole peg test (NHPT). The study showed lower significance in female as compared to males in improving hand function¹²

Sandra Mendoza-Sánchez et al in 2022 did a study to find out the reliability and agreement of 9-Hole Peg test in unilateral spastic Cerebral palsy subjects and found the excellent intra-rater inter-session reliability in patients with spastic unilateral Cerebral Palsy.

Gudrun M Johansson ,et al in 2019 performed their study on the stroke group of patients and found the reliability and improvement in holding , grasping changes with improvement in motor function among them.¹³

Peripheral neuropathy effects the motor functions which further effects the grasping and holding function of hand it also causes fatigue and loss of fine object control.¹⁴

Peripheral neuropathy shows side effect like pain, numbness and delay in motion and may also cause arthritis, CTS ,and HIV which worsened the condition¹⁵

It is clinically used to measure the functions of upper extremities and their performance. Therefore, we used 9-hole peg board test for our current study.

The Nine Hole Peg test consists of a rectangle base box with nine holes and nine pegs. The subject is instructed to insert the nine pegs, one by one, into these holes at the maximum possible speed. The pegs should be removed from the holes, one by one, and replaced back in the container. The NHPT registers the time that the subject takes to complete the task. This process must be done with both hands independently which was validated by Oxford GK et al in 2008¹⁶

TB patients who are experiencing nerve damage will not show any early signs or symptoms but may show symptoms like burning, tingling sensation, problems in walking and tapping symptoms may occur unilaterally or bilaterally.

Mostly symptoms are localized to the feet and/or the hands which is described as a classic “stocking and glove” distribution and they are often bilateral. Patients may have worse sensations at night and may describe pain, burning, numbing, cold, or restless sensations and also affects hand dexterity of the patients.

The NHPT was included in a study by Felder, et al in 1994. They suggested that dexterity tests could help identify patients who are unable to perform adequate oral self-care and that these tests could be used to estimate brushing ability among elderly compromised patients.¹⁷

Conclusion

In this current study, we examined the effects of 9-Hole Peg Board Test on hand dexterity among Tuberculosis patients. The 9HPB test is recommended as a gold standard test for measuring manual dexterity and easy to administer and is acceptable to patients.

120 subjects were enrolled for the study as per the inclusion criteria and those were not eligible as per the inclusion criteria were excluded from the study. The



subjects were instructed to pick the peg from the side of the board and stopwatch was started. The subject was instructed to be as quick as he can while performing the task. The Nine Hole Peg Test was conducted with the dominant arm first. One practice trial (per arm) was provided prior to timing the test. Timing was recorded with a stopwatch (in seconds).

The stopwatch was started when the patient touched the first peg. The stopwatch was stopped when the patient placed the last peg in the Board. The reading was taken through both dominant and non-dominant hands. The Data was recorded continuously for 2 days to check any improvement in the performance of the patient.

Pearson's Correlation Coefficient test was done to calculate the result. Correlation between Day 1 and Day 2 of 9HPB with Dominant hand was significant with $r=0.948$. There was highly significant correlation between the readings of both days.

Correlation between Day 1 and Day 2 of 9HPB with non-dominant hand was significant with $r=0.933$. There was highly significant correlation between the readings of both days. Comparison between Day 1 and Day 2 of 9HPB reading of dominant and non-dominant hand. It was significant for dominant hand with $P=0.036$ and was non-significant for non-dominant hand with $P=0.661$.

The present study proves that there is a significant effect of 9 Hole Peg Board testing on Dominant hand as well as on non-dominant hand whereas if comparison is done between dominant and non-dominant hand, significant effect is seen maximally on dominant hand.

Clinical Relevance

- Clinical relevance says that it is important to check hand dexterity in Tuberculosis patients because TB affects the motor functions and leads to weakness thus further leading to loss of normal hand functions which further affects the daily activities of the individual.
- Use of 9HPB test has proved beneficial in various conditions. It not only improves hand dexterity but also affects the quality of life in a positive way and the patient becomes independent.

Advantages of our Study

- 9HPB is easy to demonstrate and is also acceptable by the patients.
- 9HPB leads to improvement in fine motor functions thereby increasing hand movements and further improving the hand deformities which is caused by any disease whatsoever. In our study, improvement is seen in Tuberculosis patients.

Limitations of our Study

- Patients were unable to visualize the pegs properly due to low eyesight
- The protocol was followed only for 2 days although there are many different protocols for the same.
- Patients were unable to understand the command properly.

Future Scope

- Future studies can be done but must focus on increasing the days throughout the protocol for better results.
- Also, this testing can be done in other conditions also which prove that there is peripheral neuropathy present.


Conflict of Interest

There was no conflict of interest reported among all the authors of this clinical research.

References

1. Barberis, I.; Bragazzi, N. L.; Galluzzo, L.; Martini, M. The History of Tuberculosis: From the First Historical Records to the Isolation of Koch's Bacillus. *Journal of Preventive Medicine and Hygiene* 2017, 58 (1).
2. Kaye, K.; Frieden, T. R. Tuberculosis Control: The Relevance of Classic Principles in an Era of Acquired Immunodeficiency Syndrome and Multidrug Resistance. *Epidemiologic Reviews* 1996, 18 (1), 52–63. <https://doi.org/10.1093/oxfordjournals.epirev.a017916>.
3. Kochi, A. The Global Tuberculosis Situation and the New Control Strategy of the World Health Organization. *Tubercle* 1991, 72 (1), 1–6.



- [https://doi.org/10.1016/0041-3879\(91\)90017-m](https://doi.org/10.1016/0041-3879(91)90017-m).
4. Davies's textbook of adverse drug reactions | WorldCat.org. search.worldcat.org. <https://search.worldcat.org/title/daviess-textbook-of-adverse-drug-reactions/oclc/41114495?referer=di&ht=edition> (accessed 2024-05-11).
5. *Handbook of Clinical Neurology* | Elsevier. www.elsevier.com. <https://www.elsevier.com/en-in/books-and-journals/book-series/handbook-of-clinical-neurology> (accessed 2024-05-11).
6. Goodkin, D. E.; D Hertsgaard; J Seminary. Upper Extremity Function in Multiple Sclerosis: Improving Assessment Sensitivity with Box-And-Block and Nine-Hole Peg Tests. *PubMed* 1988, 69 (10), 850–854.
7. Moorthy, R.; John, S.; Sebastian, T.; Rajshekhar, V. Evaluation of Hand Function in Healthy Individuals and Patients Undergoing Uninstrumented Central Corpectomy for Cervical Spondylotic Myelopathy Using Nine-Hole Peg Test. *Neurology India* 2017, 65 (5), 1025. https://doi.org/10.4103/neuroindia.ni_12_17.
8. Smith, Y. S. NORMATIVE and VALIDATION STUDIES of the NINE-HOLE PEG TEST with CHILDREN. 2000, 90 (3), 823–823. <https://doi.org/10.2466/pms.90.3.823-843>.
9. AnadelosReyesGuzm n.Google.com. <https://scholar.google.com/citations?user=acRRnQ4AAAAJ&hl=en> (accessed 2024-05-11).
10. Warpe, B.; Poflee, S.; Pande, N.; Shrikhande, A. Tuberculous Neuritis: A Rare Sequel of a Common Disease. *Indian Journal of Pathology and Microbiology* 2014, 57 (1), 69. <https://doi.org/10.4103/0377-4929.130902>.
11. E. Matthew Hoffman; Staff, N. P.; Robb, J. M.; St, J. L.; Dyck, P. J.; Klein, C. J. Impairments and Comorbidities of Polyneuropathy Revealed by Population-Based Analyses. 2015, 84 (16), 1644–1651. <https://doi.org/10.1212/wnl.0000000000001492>.
12. Smith, Y. A.; Hong, E.; Presson, C. Normative and Validation Studies of the Nine-Hole Peg Test with Children. *Perceptual and Motor Skills* 2000, 90 (3), 823–843. <https://doi.org/10.2466/pms.2000.90.3.823>.
13. Mendoza-Sánchez, S.; Molina-Rueda, F.; Florencio, L. L.; Carratalá-Tejada, M.; Cuesta-Gómez, A. Reliability and Agreement of the Nine Hole Peg Test in Patients with Unilateral Spastic Cerebral Palsy. *European Journal of Pediatrics* 2022, 181 (6), 2283–2290. <https://doi.org/10.1007/s00431-022-04423-w>.
14. Johansson, R. S.; Westling, G. Roles of Glabrous Skin Receptors and Sensorimotor Memory in Automatic Control of Precision Grip When Lifting Rougher or More Slippery Objects. *Experimental brain research* 1984, 56 (3), 550–564. <https://doi.org/10.1007/bf00237997>.
15. National Institute of Neurological Disorders and Stroke. *Peripheral Neuropathy* | National Institute of Neurological Disorders and Stroke. www.ninds.nih.gov. <https://www.ninds.nih.gov/health-information/disorders/peripheral-neuropathy>.
16. Mathiowetz, V.; Weber, K.; Kashman, N.; Volland, G. Adult Norms for the Nine Hole Peg Test of Finger Dexterity. *The Occupational Therapy Journal of Research* 1985, 5 (1), 24–38. <https://doi.org/10.1177/153944928500500102>.
17. Felder, R.; James, K.; Brown, C.; Lemon, S.; Reveal, M. Dexterity Testing as a Predictor of Oral Care Ability. *Journal of the American Geriatrics Society* 1994, 42 (10), 1081–1086. <https://doi.org/10.1111/j.1532-5415.1994.tb06213.x>.