

REVIEW

Upper Extremity Capability Tests in Multiple Sclerosis

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ABSTRACT

Multiple sclerosis is a chronic demyelinating disease. Since attacks are accompanied by psychiatric and physical disabilities, additional symptoms such as withdrawal from the social environment and psychiatric disorders are also observed. It is very important to evaluate patients adequately and correctly, to determine the disability, and treat them with appropriate clinical approach. For this reason, Expanded Disability Status Scale score and upper extremity capacity measurement

tests are used in many studies by investigators. These tests provide detailed examination on the patient's upper limbs, and indirectly provide information about their cognitive function. A multi-disciplinary approach for multiple sclerosis patients is the most crucial factor in clinical follow-up and treatment success.

Keywords: Multiple sclerosis, capability tests, upper extremity

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UPPER LIMB FUNCTIONS IN PATIENTS WITH MULTIPLE SCLEROSIS

Multiple sclerosis (MS) is chronic demyelinating disease central nervous system which is characterized with neurodegeneration, inflammation, axonal demyelination (1-3). Especially, it affects young women. Due to the clinical and/or radiological attacks, patients have significant and irreversible mental and physical symptoms such as muscle weakness, disability of walking, balance problems, spasticity, fatigue, cognitive impairment and depression (4)

The majority of people with multiple sclerosis (MS) has upper limb dysfunction like tremor, coordination deficit and muscle weakness on the disease duration (5). The upper limb activity is essential for daily activity of MS patients. These deficits may differ in MS patients according to MS types, neuron reserves and neuroplasticity. (6)

In a study conducted by Holper et al., abnormal findings in muscle power and tone functions, gait pattern functions, mobility of joint functions, muscles sensitivity, movement functions, involuntary movement functions, psychomotor functions, spinal cord and related structures, and lower and upper extremity structures were found in more than 50% of MS patients (n: 205 patients; mean EDSS [Expanded Disability Status Scale]: 3.7) (5, 7) When MS forms are considered in terms of aforementioned abnormal symptoms, it has been proven that the secondary progressive multiple sclerosis (SPMS) patients have more significant abnormalities compared to relapsing remitting multiple sclerosis (RRMS) patients. Besides, progressive form of patients experienced more serious and irreversible neurological defects such as hemiparesis compared to RRMS Patients. Furthermore, in comparison with SPMS patients, RRMS patients are presented with visual symptoms more frequently. When we look at their upper limb functions, the patients with MS had loss of fine motor movements (67%), difficulty in lifting and transporting objects (59%) and

decrease in writing ability (56%). These malformations in motor functions leads intense depressions and consequently reduces patient's quality of life. 77 patients (37.6%) have mild depressive symptoms and 47 patients (22.9%) have severe depression (7).

On the other hand, according to another study which includes 44 MS-patients, most difficult movements of MS patients are stated to be nail cutting, hammer usage, fruit-vegetable peeling, buttoning up, mixing and distributing cards However, eating a sandwich, washing hands, using remote control, drinking beverages, brushing teeth are the movements which are generally easiest for the patients with MS (8).

The pathophysiology of MS has not been revealed yet. As we know, MS can damage both grey and white matter of the brain. Studies showed that the grey matter pathology, which is end up with cortical atrophy and cortical thinning, may not be directly related with disability measured through Expanded Disability Status Scale (EDSS). unlike white matter lesions (9). On the other hand, similar to grey matter loss, functional connectivity network damage in brain is also related with disability functional abnormality observed in MS Patients (10-13) Both interruption of the interhemispheric connections including the frontal, subcortical and occipital-temporal regions, and the cortical thinning in the occipital-temporal regions have an important role in the capability of motor functions of upper extremity (14).

The sensorimotor network in brain is related with motor dysfunction in human brain. In some studies, including functional magnetic resonance imaging (fMRI), the sensorimotor network has shown functional connectivity decrease among MS patients (15, 16), which is correlated with upper and lower motor disability (16). Notable, on the contrary, relevant correlation is not observed surprisingly in early MS patients. (10,

12, 17). This situation may be resulted from balances shifting between neuronal damage and compensatory mechanisms as MS disability progresses by the time (10) Changes in ipsilateral motor network activity is found to be linked to upper limb motor function in clinical isolated syndrome (18, 19) and RRMS (20). In the literature, overall support, this could be explained by the increases observed in both intra- and inter-hemispheric effective connectivity within the motor network contribute to the maintenance of motor function and limit the functional expression of neuropathological abnormalities (14, 15, 21).

THE CAPACITY TESTS OF UPPER EXTREMITY

The terminologies of capacity and performance are quite different. Capacity represents maximum effort that can be reached. However, we can call for people that the ability to perform a task or take an action and/or the highest functionality that any subline can reach at any time; to ability or functionality in the standard environment for the tests. Performance represents the situation in the natural environment of the uninvolved patient.

Health-related quality of life (QOL) is shown to be decreased in MS patients. It may be related with the irreversible neurological symptoms and mental function deterioration of walking, and balance problems in patients. Besides, quality of movement in the upper extremities is a result of an interplay among cognitive, sensory, perceptual, cultural, and motor factors. Because of these disabilities, MS patients have serious psychological distress which is resulted in an increase in the risk of mortality.

The EDSS score is the most common evaluation used by clinicians for impairment of MS-patients. However, in clinics, this test has given limited ability to detect disability progression in MS-patients like cognition. Therefore, additional tests have been proposed to evaluate MS patients in more detail for quality examination.

Recent studies have reported upper extremity movements and cognition angle. As authors stated, the upper extremity, especially the hand functions, is indirectly associated with the cognition. Therefore, detailed evaluation of the upper extremities of multiple sclerosis patients proved additional importance for their cognition.

For upper extremity function, it is known that there are many tests for upper extremity capacity measurement. In these tests, the most commonly used for the upper extremity was the nine-hole peg test. However, there are 6 significant and capacity tests used clinically for patients.

Melbourne Assessment of Unilateral Upper Limb Function (Melbourne Assessment/Melbourne Assessment-2)

It is a valid and reliable tool for evaluating quality of upper limb movements. This test can be used for the children between the ages of 5 to 15 years to evaluate neurological dysfunctions for all diseases including mainly multiple sclerosis and cerebral palsy. There are seven main tasks to detect upper extremity function: to reach; to grasp; to release; manipulation; pointing; pronation/supination; bilateral transfer. Elements of movement quality score is separated with range of movement, accuracy of reach/ placement, fluency, dexterity of finger movements, bilateral coordination of a speed. All categories for each task/action is pointed as one.

This original test has limited the clinical application of the tool for babies and children being under 5 years. This young-ages range and excluded younger children who are often targeted to receive early intervention. For this reason, the investigators reported in most studies to establish evidence of validity and reliability and to modify this test for using younger children. (22–24). As a result of these studies, new and common used test call is said to be Melbourne Assessment-2 (MA2) which includes 14 test items, comprising 30 items scores organized into four separate uni-dimensional sub-scales. The MA2 can be used in children aged 2.5 to 15 years who have either a congenital (for example, cerebral palsy) or an

acquired neurological condition. The MA2 has been developed also for children with a range of different movement disorders.

Nine-Hole Peg Test (9-HPT)

Nine-hole peg test (9-HPT) has been used in most common capacity test of upper limb functions in MS patients. The 9-HPT is a brief, standardized, quantitative test for the evaluation of upper extremity dysfunction. The 9-HPT has high inter-rater reliability. There is evidence for concurrent and convergent validity as well as sensitivity to detect minor impairments of hand function. Additionally, it is the second component of the multiple sclerosis functional composite which includes 25-foot walk, Auditory Serial Addition Test, PASAT. Each hemisphere can be tested by nine-hole peg test. The wood or plastic block contains nine empty holes. (Figure 1) During the test, the patients would seat at a table with small shallow container and put them in the nine holes and then remove them again as quickly as possible. The total time to complete the task is recorded. This test should be made by right and left hand separately. Total administration time should be approximately 10 minutes or less. It is a test based on finger skills and is not enough alone. The participant can be learned this test when it is repeated again (25, 26).

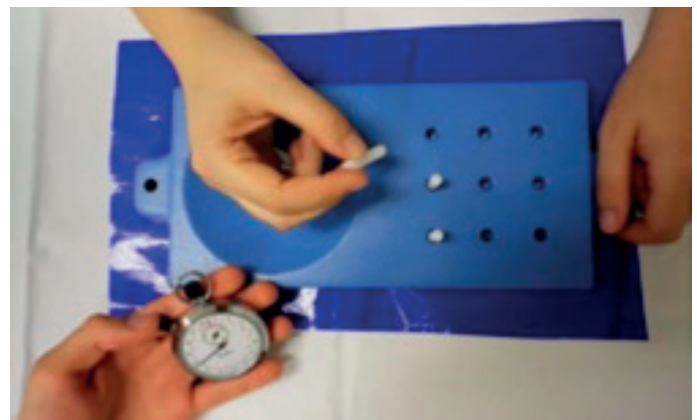


Figure 1. Nine-Hole Peg Test.

Jebsen Taylor Hand Function Test (JHFT)

The Jebsen Taylor Hand Function Test (JHFT) was designed to provide a short, objective test of hand function for the activities of daily living. The Jebsen Hand Function Test (JHFT) is a standardized evaluative measure of functional hand motor skills (27). The JHFT was developed in 1969 by Jebsen, Taylor, Treischmann, Trotter, and Howard. It has two modified forms revised by Agnew and Maas (1982) and by Bovend'Erdt et al. (2004). The first modified form has 3-item version (Modified Jebsen Hand Function Test, MJT) which determines gross unilateral or bilateral upper limb impairment. The second one, an 8-item Australian version, consists of the original 7 items with the addition of a grip strength item and dynamometer. These 7 items consist of writing, turning over 3 by 5 inch cards, picking up small common objects, simulated feeding, stacking checkers, picking up large with 9-HPT in light objects and picking up large heavy objects. It should be taken within 15–45 minutes by administer and should be started by non-dominant hand firstly. It only measures the application time, not the quality of the movements. It is correlated MS-patients, there is no other psychometric study yet (28).

Purdue Pegboard Test

The Purdue Pegboard test is a time oriented physical test used for the measurement of fine motor skills. It is reproducible because it does not have learning effect unlike nine-hole peg test. This test comprises of four subtests: two unilateral (right/left hand) and bilateral performance. The total number of pins inserted in the allotted time is the target score (29). In detail; individuals have a place of small pins into holes in the board to

Jebsen Hand Function Test Worksheet		
Patient Name:		Date:
The tests are performed with the non-dominant hand first.		
The results are measured by timing the time taken in seconds to accomplish each task.		
This test is in Medigraph Software → Coordination and Dexterity → Fine and Gross Motor → Jebsen Hand Function		
Item	Dom (s)	NonDom (s)
Writing		
Card Turning		
Small Common Object		
Simulated Feeding		
Checkers		
Large Light Object		
Large Heavy Object		

Figure 2. Jebsen Taylor Hand Function Test Worksheet.

use a specific hand and to follow a specific process. Learning disabilities, or a probable performance indicator for those applying for assembly jobs can be diagnosed with Purdue Pegboard test.

It consists of five scores. In the first part of the test, participants are given 30 seconds to place as many pins in the right-hand column of holes as many as possible. In the second part of the test, this process is repeated by using the left hand and the left-hand column of holes.

In the third part of the test, participants have 30 seconds to place pins into both right and left columns at the same time. The fourth test score is calculated with the first two scores, which does not require the individual's participation.

The last part called the assembly test, participant has 60 seconds to complete as many assemblies as possible. The participant is directed to pick up a pin and insert it into a hole with the right hand and pick up a washer and place it over the pin with the left hand. Then, again the participant picks up a collar and places it over the pin with the right hand and places a final washer on top of the collar with the left hand. Right after, moves to the next hole and repeats the process

Since the test is time measured, it allows the ability to evaluate progress in an objective, clear and measurable way (30).

Box and Block Test

The test assesses the gross upper limb coordination and dexterity. Although it is valid for MS-patients, the result of this test is not reliable for MS patients Cubes are used in the box and block test where participants focus on picking up the cubes. Precise placement of the blocks is not required (30).

Minnesota Manual Dexterity Test

Participants plumb gross hand-arm dexterity in this test and eye-head coordination is measured. The capability of picking up, placing and turning 60 wooden disks are checked in the test. The score is calculated over the average performance time. The score time is inversely correlated with the quality of patients' life's. In Minnesota manual dexterity test, a person places round pegs into holes on a punched-out sheet. Capability to grab and place objects is determined. This test has some limitations caused by carpal tunnel, and dexterity problems from other hand and

wrist injuries. It can also be used to assess the ability to perform assembly line and manufacturing work (30).

Except for these capacity tests, there are other similar type of tests used for upper extremity capacity measurement. However, their validity is unclear and it is very rare that they are performed in clinical trials of patients with multiple sclerosis.

Upper extremity capacity tests are used in MS patients to measure both clinical progression and patients' responses to rehabilitation types. Nine-hole pegs are the most commonly used tests in the evaluation of upper extremity functions in MS patients in clinical trials (31-33). EDSS testing, which is insufficient to show disease progression, is supported by additional tests in studies. The nine-hole peg test provides important information for MS patients to detect progression (34). For example, a study, which is used nine-hole peg test, within a 24-week trial of a seconder progressive MS patient showed that 20% change the point of nine hole-peg test was associated with clinically meaningful progression (35).

These tests can be performed individually. However, with a combination of tests with clinical interventions, we provide more information about patients' capacity measurements. Another study which used EDSS and Purdue Pegboard tests in patients with MS, mentioned that the capacity loss of upper limb predicts the close disability for MS patients, and emphasized the importance of early rehabilitation (36). Thus, a study using the Purdue Pegboard test supported this study by indicating that 8-week home rehabilitation reduces disability in MS patients (37). In addition, according the study by Mendes using the box and block test (38), it is argued that upper extremity capacity was statistically more impaired in males (80.7%) than females (64.8%).

In summary; multiple sclerosis is a chronic demyelinating disease. Attacks are accompanied by additional symptoms such as psychiatric disorders, withdrawal from the social environment due to physical and cognitive disability. In order to evaluate patients adequately and correctly; It is very important to determine the disability and the appropriate treatment with clinical approach. For this reason, EDSS score and upper extremity capacity measurement tests are used in many studies by investigators. These tests provide more detailed examination of the patient's upper limbs and indirectly provide information about their cognitive function. A multi-disciplinary approach for multiple sclerosis patients is the most important factor in clinical follow-up and treatment success.

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