

Association between the Hopkins Falls grading scale and motor function tests in patients with multiple sclerosis

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ABSTRACT

Introduction: One of the main complications of multiple sclerosis (MS) is imbalance and walking problems that can lead to falls. This study investigated the association between a fall measurement scale called the Hopkins Falls Grading Scale (HFGS) and motor function tests in patients with MS. **Material and Methods:** This cross sectional study was conducted using convenience sampling on 85 patients referred to the MS Association of Mashhad, Iran, in 2023. The HFGS examined falls during the past year and divided them into 4 degrees, and the function test included the timed 25 foot walk (T25FW) test and the timed up and go (TUG) test. Kruskal-Wallis test and Spearman's correlation coefficient were used for data analysis. **Results:** A statistically significant association was obtained between HFGS and functional tests (T25FW and TUG) (for both $P < 0.0001$). A significant association was observed between the variables of age ($P = 0.006$), duration of the disease ($P = 0.03$), the use of mobility devices ($P = 0.05$), and HFGS. **Conclusion:** Considering the association between HFGS and motor function tests in MS patients, clinical experts should pay attention to patients who have slower movement and evaluate them in terms of falling status when performing motor function tests.

Keywords: Hopkins Falls grading scale, multiple sclerosis, timed 25-foot walk test, timed up and go test, motor function

Introduction

Multiple sclerosis (MS) is a chronic autoimmune and inflammatory neurological disease of the central nervous system. The incidence of MS is increasing in developed and developing countries.^[1] As a country in the Eastern Mediterranean region, Iran has an increasing prevalence of this disease.^[2]

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MS is associated with many complications and affects different aspects of the patients' lives. One of the main symptoms and complications associated with MS is imbalance and walking problems.^[3,4] Having poor balance can lead to falls, injuries, and reduced activities.^[4] It also causes other complications such as fractures, scratching, endangering mobility, and loss of self-confidence in performing tasks.^[5] Some studies have shown that the prevalence of falls in people with MS is higher than in other patients with balance disorders.^[5] A meta-analysis reported a fall rate of 56% over a 3-month period in patients with MS.^[6]

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Some factors increase the chance of falling in MS patients, such as longer disease duration, progressive disease, more severe disability based on the Expanded Disability Status Score (EDSS), and a worse cognitive status.^[7-12] A history of previous falls is a strong risk factor for falls. As such, accurate identification of a fall event is critical for risk stratification.^[13]

A problem related to falls in patients with MS is the lack of a simple clinical method to assess these patients. Recording of fall events is often subjective and imprecise, which limits clinical practice and fall research. The Hopkins Falls Grading Scale (HFGS) is a scale for assessing falls. This scale classifies patients based on the use of medical services. It is easy to use and partially solves the problem of remembering the severity of the event. Moreover, it identifies near-falling attacks.^[13] So, family physicians and primary care providers in private clinics or government departments can use this scale to record and evaluate fall events among patients.

Standard tests used to evaluate the motor function of MS patients, such as the timed 25-foot walk (T25FW) and timed up and go (TUG) tests, can be related to the state of falling in MS patients.^[14] It was found that performing 1-second-slower motor function tests increases the probability of falling by 6%–20%.^[14] Accurate reporting of fall events and their predictive factors are essential in the development and evaluation of strategies to reduce the risk of falls in patients. Primary care physicians and general practitioners of patients with MS need to take this into account.

Since falls are very common in patients with MS and are associated with many complications, it is necessary to measure them accurately and evaluate their relationship with various factors, including the motion status. In this way, we can design therapeutic and preventive interventions. This study aimed to investigate the association between the HFGS and motor function tests, including the T25FW and TUG tests, in patients with MS and identify some factors affecting them.

Materials and Methods

Participants

This cross-sectional study was conducted on 85 MS patients referred to the MS Association of Mashhad (Iran) in 2023. The data were collected by convenience sampling. Age above 16 years and below 75 years and not suffering from any other disease that interfered with the ability to walk were the inclusion criteria. Dissatisfaction or disability to perform the test would lead to exclusion from the study.

Measurements

First, a questionnaire was administered that included the following variables: age (years), age of onset (years), sex, duration of the disease, drugs used by the patient (classified into the following three groups based on the type of drug: the

first-line included teriflunomide, dimethyl fumarate, interferon beta-1^a, and fampridine; the second-line included fingolimod and natalizumab; the third-line included rituximab and ocrelizumab), and the use of mobility devices such as a walker or cane (has/has not).

HFGS

This scale records the number of falls in the last year and puts patients into four categories based on the severity of falls: Grade 1 indicates a near-fall (slip, loss of balance, but the person does not fall to the ground). Grade 2 indicates a fall without physical injury. Grade 3 indicates a fall that requires medical attention. Grade 4 indicates a fall that requires hospitalization. Moreover, if a person did not fall or did not have a near-fall, they are classified in the “no history of falling” group. If the person has not fallen in the last year but has experienced at least one near fall, they are classified in the “with a history of near falls” group. If a person has fallen at least once in the past year, they are classified in the “with fall history” group. In the current study, the number of falls with this scale for the last month was also examined. The HFGS was designed by Davalos *et al.*^[13] (2013). The content and face validity of this scale have been confirmed. This instrument has shown a high internal convergence coefficient (ICC = 0.99).

T25FW test and TUG test

These tests are considered the gold standard for motor function in MS clinical trials. The use of these two tests has been recommended by the Multiple Sclerosis Outcome Assessment Working Group as a measure for assessing MS patients’ ability to walk and move. In the T25FW test, the patient is guided to the end of a 25-foot path as quickly and safely as possible. The time is calculated from the command to start the movement and ends when the patient reaches the 25-foot point. This action immediately continues by asking the patient to return from the same path. The final score of the test is the average round trip time. Patients can use mobility devices while performing this test. The reliability of this test has been checked by Phan Ba *et al.* (ICC = 0.94).^[15]

In the TUG test, the subject is asked to stand up from a chair, walk 10 feet, turn around, return to the chair, and sit on it. The final score of the test is from the beginning of the movement command to sitting back on the chair. The validity of TUG in people with MS has been approved (ICC = 0.99).^[16]

Data analysis

In the analysis of the data, the normality of the data has been investigated by using the Shapiro – Wilks test. Kruskal – Wallis tests and Dunn – Bonferroni *post hoc* test were used for non-normal data. Spearman’s correlation coefficient was used to check the correlation. The software used in this research is SPSS v. 25, and the significance level of the tests is considered less than 5%.

Ethical considerations

All the participants provided informed consent. This research has an ethics code (IR.IAU.MSHD.REC.1401.036).

Results

In this study, 68.20% of the patients were women. Most of the patients were in the age group of 35-45 years (38.82%). Other characteristics of the participants are presented in Table 1.

Table 2 shows the results of the HFGS and performance test of the MS patients. According to the HFGS, 36.47% of the participants did not report any incident of falling in the last year and last month. Moreover, other patients had experienced near-falls or falls. The number of falls based on the HFGS, and the mean and median of the T25FW and TUG tests are presented in Table 2.

Table 3 shows the distribution of the variables based on the HFGS classification. The mean age of the patients ($P = 0.006$), the duration of the disease ($P = 0.03$), the use or non-use of

mobility devices ($P = 0.05$), and the use of drugs ($P = 0.04$) showed a statistically significant difference in grades of the HFGS.

Table 4 shows the association between HFGS, TUG, and T25FW tests. Based on the results of the Kruskal–Wallis test, the mean score of the TUG test at different levels of the HFGS had a statistically significant difference ($P < 0.0001$). Furthermore, the T25FW test showed a significant association with the HFGS ($P < 0.0001$). The correlation coefficient between both performance tests and the HFGS was positive and significant (for TUG $P < 0.0001$ and for T25FW $P < 0.0001$).

Discussion

This study determined the association between falls measured by the HFGS with motor function tests, including T25FW and TUG. The findings showed a significant association between the HFGS and both functional tests. Besides, age, duration of the disease, use of mobility devices, and use of drugs had significant differences in different grades of the HFGS.

In the present study, 42.35% of the participants reported that they had experienced at least 1 fall based on the HFGS. Also, 21.18% reported near-falls. A 2018 study by Fritz *et al.*^[14] using the HFGS on 135 patients with MS showed that 30% of the participants reported falling in the past year, and 44% had near-falls. According to the results of the study by Fritz *et al.*,^[14] pseudo-fall or near-fall experiences were common. In the study by Matsuda *et al.*^[8] (2011) in the United States, of 474 MS patients, 58.2% of the patients reported falling at least once during the last 6 months. In the aforementioned study, 18.9% of the cases required medical intervention, while in our study, 8.23% of the patients needed medical care or hospitalization. The percentage obtained from the number of falls in our study is higher than that of Matsuda *et al.*'s^[8] study, which can be attributed to different scales of measuring falls, the difference among the patients in terms of the severity of the disease, and the difference in the period investigated compared to our study.

Table 1: Demographic characteristics in patients with MS (n=85), Mashhad, 2023

| Characteristics | Subcategory | Frequency (%) |
|-------------------------|-------------------|---------------|
| Sex | Female | 58 (68.20) |
| | Male | 27 (31.80) |
| Age | Mean±SD | 36.85±8.62 |
| | Range | 16-60 |
| Age category | 16-25 | 10 (11.76) |
| | 25-35 | 29 (34.12) |
| | 35-45 | 33 (38.82) |
| | 45 and more | 13 (15.29) |
| Age at onset | Mean±SD | 29.25±8.81 |
| | Range | 12-56 |
| Duration of the disease | Mean±SD | 7.60±6.06 |
| | Range | 1-20 |
| Type of drugs used | No use | 17 (20.00) |
| | First-line drugs | 12 (14.12) |
| | Second-line drugs | 9 (10.59) |
| | Third-line drugs | 47 (55.29) |
| Mobility devices | No | 74 (87.06) |
| | Yes | 11 (12.94) |

Table 2: Hopkins Falls grading scale and motor function tests in patients with MS (n=85), Mashhad, 2023

| Name of test | Frequency (%) | Total fall in last month | Total fall in past year |
|-------------------------------|---------------|--------------------------|-------------------------|
| Hopkins Falls Grading Scale | | | |
| Not faller | 31 (36.47) | 0 | 0 |
| Near-faller–grade 1 | 18 (21.18) | 114 | 442 |
| Fallers–grade 2 | 29 (34.12) | 49 | 369 |
| Fallers–grades 3 and 4* | 7 (8.23) | 12 | 111 |
| Timed 25-foot walk test | | | |
| Time for forth (s) (mean±SD) | 10.47±6.68 | - | - |
| Time for back (s) (mean±SD) | 10.90±7.03 | - | - |
| Total time (s) (mean±SD) | 21.37±13.40 | - | - |
| Average time (s) (mean±SD) | 10.68±6.69 | - | - |
| Average time (s) (median±IQR) | 8.35±4.20 | - | - |
| Timed up and go test | | | |
| (s) (mean±SD) | 13.63±9.62 | - | - |
| Average time (s) (median±IQR) | 10.20±6.20 | - | - |

*Only one person was placed in grade 4

Table 3: Hopkins Falls grading scale by demographic variables in patients with MS (n=85), Mashhad, 2023

| Grade | Age (Mean±SD) | Age at onset (Mean±SD) | Female sex Frequency (%) | Duration of the disease (Mean±SD) | Use of mobility devices (Yes) Frequency (%) | Drug use (yes) Frequency (%) |
|----------------|---------------|------------------------|--------------------------|-----------------------------------|---|------------------------------|
| Not fall | 32.74±7.62 | 27.39±7.89 | 18 (31.03) | 5.34±5.68 | 2 (18.18) | 20 (29.41) |
| Near-fall | | | | | | |
| Grade 1 | 37.06±6.08 | 28.39±6.94 | 14 (24.14) | 8.67±6.68 | 1 (9.09) | 15 (22.06) |
| Falls | | | | | | |
| Grade 2 | 40.79±9.63 | 32.31±10.61 | 22 (37.93) | 8.48±5.44 | 5 (45.45) | 26 (38.24) |
| Grades 3 and 4 | 38.14±6.89 | 27.00±6.51 | 4 (6.90) | 11.14±6.36 | 3 (27.27) | 7 (10.29) |
| P | 0.006* | 0.17* | 0.33† | 0.03* | 0.05† | 0.04† |

*P from Kruskal–Wallis tests †P value from Chi-square test

Table 4: Association between Hopkins Falls Grading Scale and motor function tests in patient with MS (n=85), Mashhad, 2023

| | TUG* (s) (Mean±SD) | T25FW* (s) (Mean±SD) |
|--|--------------------|----------------------|
| Not faller | 9.71±3.72 | 8.08±4.38 |
| Near-faller–grade 1 | 10.62±3.29 | 7.95±2.37 |
| Fallers–grade 2 | 16.51±8.77 | 13.31±7.38 |
| Fallers–grades 3 and 4 | 26.83±22.09 | 18.39±10.10 |
| P (Kruskal–Wallis ’s test) | <0.0001 | <0.0001 |
| P (Spearman’s correlation coefficient) | <0.0001, r=0.54 | <0.0001, r=0.55 |

*Timed 25-foot walk test, Timed up and go test

In this study, the average final score obtained from the T25FW test was 10.68, with an SD of 6.69 and a median of 8.35. In the study by Kalinowski *et al.*^[17] (2022), which was calculated from the basic data of a cohort study, the mean score obtained for MS patients with the T25FW test was 9.2, and the median was 6.1. Their mean is close to the mean obtained in our study. Based on a meta-analysis conducted in 2020 on 17 studies that used this test to evaluate patients with MS, the average T25FW test reported for patients regardless of disease severity was 9.2 s (SD = 9.2),^[18] which is close to the value of the present study. However, in Goldman’s study, which examined the results of 14 clinical trials on MS patients, the mean obtained from 12,776 patients for the T25FW test was equal to 7.6 s (SD: 9.84),^[19] which is lower than the value in this study. In this study, the severity of the disease is not known, which has limited the possibility of exact comparison with other studies.

In our study, the mean of the TUG test was 13.63 with an SD of 9.62 s. In Nilsagard’s study, using the same test, the mean was 13.9 (SD = 6.2), which is close to the mean obtained in our study.^[20] In Sebastian’s study, which was conducted on 47 patients with MS to evaluate the validity of the TUG test, an average of 0.9 s (SD = 4.9) was recorded. For the T25FW test, the average time was 6.6 s, with an SD of 3.4.^[16] The average obtained from Sebastian’s study is lower than that of our study. Based on the results of the mentioned study, the performance of the TUG test is correlated with other tests, including the T25FW test.

In the present study, the HFGS had a significant association with the T25FW test, and there was a positive and significant correlation between these two scales in patients. Also, a significant

correlation was found between the TUG test and the HFGS, and the correlation between the two scales was direct and significant. In line with the results of our study, in the study by Fritz *et al.*^[14] that used the HFGS, non-fallers completed the walking tests more quickly than near-fallers and fallers. Fritz *et al.*^[14] reported that poorer performance in each test increased the odds of falling or experiencing a near-fall after controlling for age and disease type. A 1-s increase in the TUG test was associated with a 6% greater chance of experiencing a fall. Similarly, a 1-s increase in the T25FW test was associated with a 20% greater chance of experiencing a fall. According to the results of the aforementioned study, both tests can predict the state of falling in patients with MS.

In this study, the patients were not analyzed in terms of disease severity based on existing criteria such as the EDSS. Since the severity of the disease can affect the risk of falling,^[7,10] the lack of measurement is a limitation of the present study. Another limitation is that falls and near-falls were asked retrospectively, which can lead to measurement error and recall bias. Another limitation is the convenience sampling of the patients. Only patients who had an acceptable movement status and were able to visit the MS association were included. Therefore, people with severe illness who were unable to walk were not included, which may have affected the results. This also decreased the state of falling in the sample because people with a better condition of the disease were included in the sample.

Conclusion

The findings revealed that falls according to the HFGS can be related to the movement status of MS patients. Clinicians, general primary care providers, and family physicians should examine patients who perform the tests for a longer time in terms of falling, and preventive measures should be taken for them in the living and working environment. Longer disease duration and older age in higher grades of the HFGS can indicate a higher risk of falls. Paying attention to these factors when evaluating the movement status of patients can greatly reduce the rate of falls. It is suggested that prospective studies be conducted to measure the number of falls in MS patients so that this event can be accurately recorded and its relationship with motor function tests and the factors affecting it can be determined more precisely.

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Authors' statement

The manuscript has been read and approved by all the authors.

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Conflicts of interest

There are no conflicts of interest.

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