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Comparative Reliability of Berg Balance Scale and MAS Tests in People with Neurological Disorders

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Abstract

Background: In recent years, many tests have been developed to evaluate the mobility and functional capacity of people with neurological disorders (Hemiplegia, MS). The purpose of this study was to test the reliability and additionally to determine the measurement error of Modified Ashworth Scale and BBS in adults with neurological disorders (hemiplegia, MS). **Methods:** In the study of tests 20 adults (11 with multiple sclerosis and 9 with hemiplegia) who were retrospectively registered, participated. The average age of adults was 38.7 ± 13.9 years old and their average body mass was 65.1 ± 13.1 kgr. The Greek version of the tests and a Nikon 5300 digital camera for video recording were used for data collection. ICC was calculated, by means of a two-way ANOVA model. **Results:** The results showed that there were no statistically significant differences between the two independent evaluators and that the BBS (ICC > 0.989) had strong reliability. The reliability of Modified Ashworth Scale has been found to be average: K = 0.502, ($p < 0.001$). **Conclusions:** Overall, the results of the present investigation provided considerable evidence suggesting that the test BBS and MAS are reliable and can be used to evaluate kinetic and balance disorders. Therefore, it was concluded that the tests should be applied in order to reliably estimate the mobility and functional ability of adults with neurological disorders. More research shall be carried out in the future on other patients in order to evaluate the reliability of the above tests.

Keywords

Reliability, BBS-MAS, Hemiplegia, MS

1. Introduction

Stroke usually means the rapid onset of some neurological disorders and, more often, hemiplegia. The disorder may occur within a few seconds, although in other cases it develops over a period of hours or even days. The stroke is responsible for the 10% - 12% (in Greece 18%) of total mortality in developed countries (Western Europe-USA), while about the 88% of stroke deaths occur in people over 65 years old (deaths are most common for men). In Eastern Europe (Bulgaria, Hungary), deaths have increased in the last two decades. In general, strokes increase significantly with age. Thus, while at the age of 20 - 40 years old only 3 strokes per 100,000 population are observed per year, at the age of 70 - 90 years old 300 strokes are observed [1].

As mentioned, a common effect of a stroke is hemiplegia. It is considered to be one of the most common forms of paralysis. It is usually a spastic paralysis of one side of the body, accompanied by a severe loss of muscle strength and motor function on one side of the body including: the upper extremity and the lower limb. Because of the dysfunctions of movement, self-service, behavior, communication and disability of the body, people with hemiplegia need the help and attention of others [2].

Stroke is a major cause of adult incapacity in developed countries. Any treatment that improves functional outcome can significantly reduce the patient's disability as well as the financial cost of this disease on the individual, family, and society [3].

Multiple Sclerosis (MS) is a neurological degenerative disease of unknown etiology that causes structural and morphological changes in the CNS, brain and the spinal cord. It is characterized by demyelination of the nerve fiber sheath, altering its normal function that results in changes in various systems of the human body. The disease is more common in women than in men (1.5 - 2 to 1). The most common age in which this disease appears is 20 - 30 years old, but the appearance of the disease is not uncommon in the 5th decade of age. Rarely the disease appears before the age of 15 years old and after the 60 years old [4].

Generally, countries with higher frequency are northern Europe, Canada, the northern states of the USA and Australia. In southern Europe, prevalence ranges from 10 - 40 to 100,000 (in our country it is at 29.5), while near Equator the frequency is less than 5 in 100,000 [4].

Many strategies have been proposed to evaluate movement and balance in people with central nervous system damage such as hemiplegia and multiple sclerosis. In order to evaluate the effectiveness of intervention programs for these diseases, relative tests have been established, which have been assessed for both their reliability and their validity. In the last decade, many balance tests such as Berg Balance Scale (BBS), Tinetti Gait and Balance Instrument (Tinetti) and Time Up and Go Test (TUG) have been developed [5].

A tool designed specifically to measure functional balance is the Berg Balance Scale (BBS). The reliability of this scale has been evaluated and found to have

excellent results on elderly people as well as on individuals after an acute stroke. The validity of BBS has been partially evaluated on elderly patients and has been compared with a variety of disability measurement indicators with independence in movement and other balance-measuring tests [6].

Spasticity is a very common symptom of patients with neurological problems such as hemiplegia and multiple sclerosis. One method for measuring spasticity of patients is the passive mobilization of the examined upper or lower extremity throughout the passive range of motion by the examiner. In the last decades, researchers were interested in developing some tests to be able to reliably evaluate spasticity. One of these tests is the MAS, but its reliability is controversial. The Modified Ashworth scale (MAS) was basically developed to evaluate the efficiency of a seizure drug in patients with multiple sclerosis [7].

Bohannon and Smith (1987) added another one grade (1+) and revised the scale in an attempt to create a more sensitive scale for those suffering from hemiplegia [8].

The scale is used to give a subjective scoring of the resistance or tone ratio perceived by the examiner. MAS scale is more reliable for evaluating tone of the upper limbs [9].

2. Methodology

2.1. Aim

The purpose of this study was to test the reliability and additionally to determine the measurement error of Modified Ashworth Scale and BBS, in adults with neurological disorders (hemiplegia, MS).

2.2. Participants

In the study of tests' reliability on individuals with neurological disorders (hemiplegia, multiple sclerosis), 20 adults (11 with multiple sclerosis and 9 with hemiplegia) participated. The average age of individuals was 38.7 ± 13.9 years old and their average body mass was 65.1 ± 13.1 kgr. All participants were examined by a special neurologist. They were also selected according to the continuous sampling method, while for simultaneous control of the reliability and determination of the measurement error, each test was applied to the individuals two consecutive times in two different days (T1 & T2), which timing between them was one day.

2.3. Instrument

The following measuring instruments were used in the research:

- Berg Balance Scale (BBS). The BBS scale evaluates: 1) the ability to maintain the upright position, 2) the ability to maintain the upright position through its disruption states by external factors, and 3) the ability to maintain the upright position through its disruption from internal factors [6].
- Modified Ashworth Scale (MAS). The MAS scale is used to give a subjective

scoring of the resistance or tone ratio perceived by the examiner as a member of the body moves in its entirety. The MAS spasticity classification scale is more reliable for controlling the muscular tone of the upper and lower extremities. In particular, muscle resistance is measured after 5 repetitions of a passive movement within one second.

2.4. Procedure

The reliability of tests on patients with neurological disorders (hemiplegia, multiple sclerosis) prior to the research, the written consent of the individuals who participated in the research was required. Initially, when each individual arrived at the measurement area was obliged to complete his/her sheet with demographic and somatometric data.

All measurements were taken in a private physiotherapy practice. The main measurements were carried out in two days. At the first measurement (T1), BBS and MAS were applied to each individual randomly. In MAS test one measurement has been taken.

The second measurement (T2) was taken one day after the first measurement (T1). The performance of individuals in each test was recorded on a special sheet, while for re-checking of the correct scoring we used a JVC mini DV camera recording all individuals' attempts at all measurements. All tests were performed twice on two consecutive days.

2.5. Data Analysis

To examine the reliability we used the intraclass correlation coefficient (ICC) in order to check the reliability of the tests, while for the determination of measurement error of each test we calculated the square root of average squares of different (RMSdif) performances of each test in two different applications (T1 and T2). Especially for the MAS scale regarding adult research, the reliability has been checked using the Kappa (k) reliability coefficient because the data on the scale are quality data.

3. Results

Intraclass correlation coefficient (ICC) was used in order to check the reliability of the tests regarding the performance of each test in the two different measurements. We calculated the ICC, by means of a two-way ANOVA model, where ICC: means the intra-class correlation coefficient between the two measurements, MSs: means the average square between the measurements, MSi: means the average square of interaction between the measurements and the subjects. In addition, we have calculated: 1) The typical error or standard error of measurement; and 2) typical percentage error or coefficient of variation. In order the test to be reliable intraclass correlation coefficient of the test scores in two consecutive measurements should be ICC > 0.80. Also, the typical error should be as small as possible, while the coefficient of variation should be less than 10%.

Especially for the Modified Ashworth scale, reliability has been assessed using the Kappa (k) reliability coefficient because the data on the scale is qualitative data.

Modified Ashworth Scale

Table 1 showed that the reliability of Modified Ashworth Scale for adductor muscles has been found to be average: K = 0.502 ($p < 0.001$).

Table 2 showed that the reliability of Modified Ashworth Scale for gastrocnemius muscles has been found to be average: K = 0.502 ($p < 0.001$).

BBS

Table 3 and Table 4 showed that BBS test had very good reliability in all their performances. While the Modified Ashworth Scale's reliability for gastrocnemius muscles and adductor muscles were average.

Table 1. Modified Ashworth scale of combined values for adductor muscles at the first and second measurement.

MAS Adductor Muscles		2nd Measurement					Total
		0	1	2	3	4	
1st Measurement	0	4	0	0	0	0	4
	1	5	6	0	0	0	11
	2	0	0	1	0	0	1
	3	0	1	1	1	0	3
	4	0	0	0	0	1	1
Total		9	7	2	1	1	20

Table 2. Modified Ashworth scale of combined values for gastrocnemius muscles at the first and second measurement.

MAS Gastrocnemius Muscles		2nd Measurement					Total
		0	1	2	3	4	
1st Measurement	0	1	0	0	0	0	1
	1	3	3	0	0	0	6
	2	1	0	0	0	1	2
	3	0	0	0	1	4	5
	4	0	0	1	5	0	6
Total		5	3	1	6	5	20

Table 3. Average rate (±SD) performance of the BBS.

Performances	1st Measurement	2nd Measurement
BBS	38.20 ± 14.75	38.00 ± 14.86

Table 4. Intraclass correlation coefficients (ICC), differences at % (RMSdif), typical error (SEM) and coefficient of variation (CV%) of individuals' performance in BBS during the two measurements.

Performances	**ICC**	**RMS dif (%)** (mean ± SD)	**SEM**	**CV%** (mean ± SD)
BBS	0.989	1.81 ± 3.14	0.93	1.88 ± 3.40

*$p < 0.001$.

4. Discussion

The results showed that the tests were of high reliability for BBS (ICC = 0.936) scale, while the reliability for MAS was average regarding adductor muscles and gastrocnemius muscles K = 0.502, ($p < 0.001$), those findings are in line with the international literature [8] [10] [11] [12] [13] [14].

During the Berg Balance Scale test, the results showed that the test is very reliable for patients with neurological disorders who are suffering from hemiplegia and multiple sclerosis. In particular, the performance of the test was ICC = 0.936, RMSdif (%) (mean ± SD) = 1.81 ± 3.14 with a typical error of 0.93 and a coefficient of variation CV% of 1.88 ± 3.40. These results are in line with the findings mentioned in similar studies such as [13] Hui *et al.*, (2002) with ICC = 0.98; [15] Stephen *et al.*, (2002) with ICC = 0.98; [5] of Cattaneo *et al.*, (2006) with ICC = 0.96; [10] Blum *et al.*, (2008) with ICC = 0.98; [16] Wirtz *et al.*, (2010) with ICC = 0.95; [14] and Learmonth *et al.*, (2012) with ICC = 0.96.

As regards the Modified Asworth Scale, the reliability during the research has been checked using the Kappa (k) reliability coefficient because the data on the scale is qualitative data. During the MAS test the reliability was average regarding the adductor muscles and gastrocnemius muscles with K = 0.502 ($p < 0.001$). The findings are partially in line with findings mentioned in similar studies such as [17] Clopton *et al.* (2005), who applied another type of analysis, and the results showed good interrater reliability (intraclass correlation coefficient ICC > 0.75 for elbow flexors and thigh muscles and low interrater reliability (ICC < 0.50) for other muscles. [8] Noureddin *et al.* (2008) tested the MAS in patients with hemiplegia and found that the Kappa values for the initial Ashworth and modified Ashworth Scale were 0.17 (SE = 0.21 − p = 0.41) and 0.21 (SE = 0.12 − p = 0.08) respectively. The values in this study showed that the Ashworth scale and MAS test were not reliable for evaluating muscle spasticity [18]. Nastaran *et al.* (2009) found a good reliability of MAS test for hip adductors and knee extensions (Weighted kappa = 0.82, $p < 0.0001$) and good reliability for gastrocnemius muscles (weighted kappa = 0.74, $p < 0.0001$) [9]. While Kaya *et al.* (2011), found a high value regarding reliability of MAS test, kappa = 0.868 but measurements were taken on the spasticity of elbow muscles in patients with hemiplegia.

5. Conclusion

During the research for the reliability of tests on patients with neurological disorders, BBS scale was found reliable in evaluating the movement and functional-

ity in patients suffering from hemiplegia and multiple sclerosis. As regards the Modified As worth Scale, the reliability was average. It should be noted that for BBS scale the assessment time was about 20 minutes for each patient. On the contrary, the time for MAS test was 3 minutes for each patient. In conclusion, more research shall be carried out in the future on other patients with insufficient centralization in order evaluate the reliability of the above tests. The MAS and BBS scale are reliable and can be used to evaluate movement and functionality of people with neurological disorders. More research shall be carried out in the future on other patients in order evaluate the reliability of the above tests.

6. Limitations

As to the sample: the sample was only from a small city of Trikala in Greece as the investigation was carried out there.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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