Original Article

Spasticity Effect in relation to body mass index on dynamic postural stability in patients with stroke

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ABSTRACT

In the general population, obesity is significantly linked to an increased risk of stroke. Lower extremity impairments are common in stroke patients. As a result, motor control is impaired, balance is compromised due to asymmetric weight support, and walking ability is limited. The purpose of this investigation was to study the internship impact of spasticity and BMI on dynamic postural stability in patients with stroke. Forty-eight patients with hemiplegia/paresis after stroke, from both genders, with an age range of 45-65 years were included. MI of patients ranged between (25-40 kg/m^2). Duration of illness was over 6 months post-stroke. According to a modified Ashworth scale, patients' spasticity ranges from grade 1 to grade 4. All patients suffered from balance disturbance. This investigation revealed that there was a significant impact of BMI on TUG and FRT. There was a significant reduction in TUG of the overweight and obese subjects of mild and moderate spasticity compared with that of severe spasticity. It has been claimed that impaired balancing capability increases the risk of falling in obese people and that the incidence of falls increases as body mass increases. Obesity rehabilitation treatments for stroke patients are critical for avoiding problems.

Keywords: Stroke, Spasticity, Obesity, Balance

Introduction

Stroke is a devastating disease that causes mobility, sensory, cognitive, and perceptual impairments [1, 2], particularly in low- and middle-income nations. Because of damage to the central nervous system, motor nerves, and sensory nerves, stroke patients experience difficulties with upper and lower extremity functional activities [3-5]. Approximately 72% of stroke patients have residual impairments in their lower extremities. As a result, motor control is impaired, balance is compromised due to asymmetric weight support, and walking capacity is limited [6].

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Upper motor neuron syndrome has a favorable trait of spasticity. This is because, rather than a loss of connection to the lower motor neuron pathways, it is caused by a lack of inhibition of the lower motor neuron pathways (or other pathways). This is caused by a lesion of the upper motor neuron, which controls muscle control, resulting in a disrupted sensorimotor regulation of movement. As a result, there is a signal imbalance between the central nervous system (CNS) and muscles, which manifests as involuntary muscular activation that is intermittent or continuous [7].

In most countries, stroke is a major cause of mortality and morbidity in people. Spasticity is a common symptom in stroke victims. Spasticity after a stroke is frequently associated with discomfort, soft tissue stiffness, and joint contracture, and it can result in aberrant limb posture, poorer quality of life, higher treatment costs, and a greater load on caregivers. Early detection and treatment of post-stroke spasticity may help people with spasticity not only avoid these problems but also enhance function and independence. Spasticity is more common in upper-limb flexor muscles (fingers, wrists, and elbow flexors) than lower-limb extensor muscles (knee and ankle extensors) [8].

Measures of balance control have been linked to the occurrence of post-stroke falls, with a rate of up to 65 percent among those who have had a stroke. Equilibrium regulation is a complicated process that requires the integration of various systems that, if destroyed, can lead to loss of balance [9]. In individuals with stroke, for example, asymmetry has been documented between distributions of forces that are higher on the non-paretic leg to maintain upright balance [10].

Furthermore, in stroke patients, difficulties in actively shifting weight between the feet or relying on systems other than the damaged limbs to maintain balance (e.g., visual system and cognitive control) have been documented [10]. Psychological aspects of balance control impairment exams include fear of falling and balance. In those who have had a stroke, self-efficiency ratings are an important predictor of balance impairment [10].

Obesity is linked to an increased risk of stroke. Inflammation is likely to arise as a result of excess fat in the body, resulting in impaired blood flow and probable obstructions [11]. Multiple studies have found that having a higher BMI predicts lower mortality after a stroke or transient ischemic attack (TIA), whereas others have found no benefit to being overweight or obese after a stroke [12]. Following an acute stroke, obese persons have a better functional result than normal-weight patients. The relationship between BMI and functional impairment is not well understood [13].

This debate casts doubt on the efficacy of advising weight loss as a secondary preventative strategy for stroke in overweight and obese people [13]. The goal of our research was to see how spasticity and BMI affected dynamic postural stability in stroke patients.

Materials and Methods

Patients' selection

Forty-eight stroke patients of both genders were chosen from the outpatient clinics of neurology and internal medicine at Kasr Al-Ainy Hospitals, as well as the outpatient clinic of neurology at Cairo University Hospital's Faculty of Physical Therapy.

Inclusion criteria

Forty-eight patients with hemiplegia/paresis after a stroke as diagnosed by CT "computed topography" or MRI "magnetic resonance imaging", from both genders, and age range of 45-65 years was included. MI of patients ranged between 25-40 kg/m^2. Duration of illness was over 6 months post-stroke. Patients had spasticity ranging from grade 1 to grade 4 according to a modified Ashworth scale. Patients were medically stable. All patients suffered from balance disturbances.

Exclusion criteria

Patients with diabetes mellitus, vestibular neuritis or surgery, bilateral vestibular disorder, cervical osteoporosis, psychological disturbance, autonomic neuropathy, and fractures of lower limbs were excluded.

Design of the study

Cross-sectional “assessment study”.

Patients were randomly assigned to three equal groups

A: sixteen patients with mild spasticity (grade 1 and 1+).

B: sixteen patients with moderate spasticity (grade 2 and 3).

C: sixteen patients with severe spasticity (grade 4) according to the modified Ashworth scale.

All patients in three groups were assessed using a modified Ashworth scale to determine the degree of spasticity and clinical tests (timed up and go test and functional reach test) to evaluate postural stability.

Data collection

All participants underwent a pre-baseline assessment. Patients were assessed using the passive movement of the joints in both upper and lower limbs to detect the degree of spasticity depending on the velocity of the movement. Then, the data were equaled to a valid and reliable scale named the modified Ashworth scale. During spasticity assessment, patients should be in a relaxed comfortable position. The patients’ heads should be in mid-position, avoid touch the highly reflexogenic areas or the tested muscles.

The Functional Reach Test (FRT) evaluates the maximum forward distance that can be covered. For younger and older individuals, the Functional Reach test has been proven to have strong predictive validity, test-retest reliability, and inters observer reliability; “Reach as far forward as you can keeping your feet flat on the floor and without taking a step.”

The timed up-and-go test (TUG) is utilized to evaluate a patient's mobility and balancing requirements, both dynamic and static. It makes use of the time it takes to get out of a chair, walk three meters, turn around, return to the chair, and sit down.

Data analysis

G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany) was used to calculate sample size prior to the inquiry [F tests- MANOVA: Global effect, =0.05, =0.2, and large effect size]. It was discovered that N=48 was the optimal sample size for this study.

Statistical analysis

To compare the ages of the groups, descriptive statistics and the ANOVA-test were used. The gender distribution between groups was compared using the Chi-square test. The Shapiro-Wilk test was used to ensure that all variables had a normal distribution. Levene's test for homogeneity of variance was utilized to evaluate group homogeneity. The effect of spasticity and BMI on the mean values of TUG and FRT was investigated using a two-way MANOVA. The significance level was set at p 0.05 for all statistical tests. The statistical programme for social studies (SPSS) version 25 for Windows was used for all statistical analyses.

Results and Discussion

Subject characteristics

Table 1 depicted the mean ± SD age of the research groups. There were not any notable differences among the 3 groups in the mean age (p=0.62). Furthermore, there was not any significant difference in gender distribution among the three groups (p=0.55).

Table 1. Basic characteristics of all participants.

	Mild spasticity	Moderate spasticity	Severe spasticity	p-value
	$\bar{X}$±SD	$\bar{X}$±SD	$\bar{X}$±SD	
Age (years)	54.87 ± 4.61	53.12 ± 5.43	54.75 ± 6.7	0.62
Gender distribution,				0.55
n(%)	6 (37.5%)	8 (50%)	9 (56.3%)	
Females Males	10 (62.5%)	8(50%)	7 (43.8%)	

P-value: significance level; $\bar{X}$: Mean; SD: standard deviation

Effect of spasticity and BMI on TUG and FRT

Two-way MANOVA showed no significant effect of spasticity on TUG and FRT (Wilks' Lambda = 0.09; $F(4,82) = 45.4$, p = 0.001, $\eta^2 = 0.68$). There was a significant effect of BMI on TUG and FRT (Wilks' Lambda = 0.66; $F(2,41) = 10.2$, p = 0.001, $\eta^2 = 0.33$). There was no significant interaction of spasticity and BMI (Wilks' Lambda = 0.93; $F(4,82) = 0.69$, p = 0.59, $\eta^2 = 0.03$).

Effect of spasticity

There was a significant decrease in TUG of the overweight and obese subjects of mild and moderate spasticity compared to that of severe spasticity (p<0.001), and there was a significant decrease in TUG of the overweight and obese subjects of mild spasticity compared to that of moderate spasticity (p<0.01). **(Table 2)**.

There was a significant increase in FRT of the overweight and obese subjects of mild and moderate spasticity compared to that of severe spasticity (p < 0.001), and there was a significant increase in FRT of the overweight and obese subjects of mild spasticity compared with that of moderate spasticity (p<0.001) **(Table 2)**.

Effect of BMI

There was a significant decline in TUG of the overweight subjects of mild and moderate spasticity in comparison with that of obese cases (p<0.05), while there was no significant difference between obese and overweight subjects in the severe spasticity group (p>0.05) **(Figure 1** and **Table** 2).

A significant enhancement in FRT was observed in the overweight subjects of moderate and severe spasticity in comparison with that of obese cases (p<0.05), while there was no significant difference between obese and overweight subjects in the mild spasticity group (p>0.05) (**Table 2** and **Figure 2**).

Table 2. Mean TUG and FRT in overweight and obese patients with mild, moderate and sever spasticity.

	Mild spasticity	Moderate spasticity	Severe spasticity	p-value		
	$\bar{X}$±SD	$\bar{X}$±SD	$\bar{X}$±SD	Mild vs. moderate	Mild vs. sever	Moderate vs. sever
TUG (sec)						
Overweight	21.53 ± 6.18	38.1 ± 4.86	70.75 ± 7.27	0.001	0.001	0.001
Obese	31.66 ± 3.21	47 ± 7.48	75 ± 12.67	0.٠1	0.001	0.001
	p = 0.02	*p = 0.01*	*p = 0.29*			
FRT(cm)						
Overweight	14.61 ± 2.32	10.4 ± 1.71	6.25 ± 1.7	0.001	0.001	0.001
Obese	13.33 ± 1.52	7.33 ± 1.21	3.75 ± 0.95	0.001	0.001	0.01
	p = 0.27	*p = 0.002*	*p = 0.02*			

P-value: level of significance; $\bar{X}$: Mean; SD: standard deviation;

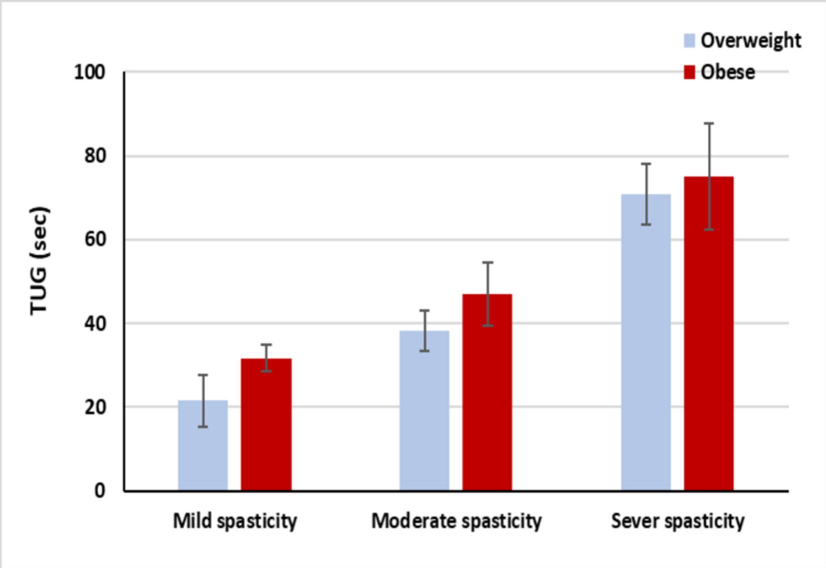

Figure 1. TUG mean in patients with severe, moderate, and mild spasticity who are overweight and obese.

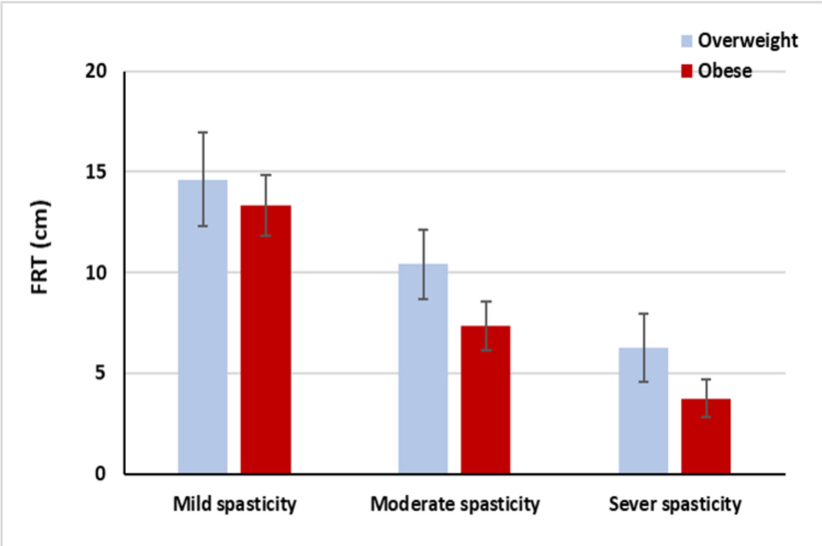

Figure 2. TUG mean in patients with severe, moderate, and mild spasticity who are overweight and obese.

Balance impairment is a prevalent impairment after a stroke that is associated with low quality of life and disability. Furthermore, balance impairment often results in high fall rates, which cause a great burden to society, patients, and their families. Besides, good balance is a prerequisite for regaining the potential for daily activities and walking independently [14]. People who have had a stroke have a higher risk of falling, and only a few research have looked into the effect of spasticity in balance control in these patients [15].

The results of the present study revealed that there is a significant decrease in TUG of the overweight and obese subjects of mild and moderate spasticity compared with that of severe spasticity, and there was a significant decrease in TUG of the overweight and obese subjects of mild spasticity compared with that of moderate spasticity. Rahimzadeh Khiabani *et al.* (2017) found that those with high spasticity had lower balance control during standing trials than those with mild spasticity and these differences are exacerbated by the lack of vision [15]. Furthermore, these balance control impairments are in the frontal plane, highlighting probable differences in mediolateral balance control in those with differing levels of post-stroke spasticity, possibly premised in the neural and biomechanical modifications correlated with more spasticity [15]. Generally, it seemed that the occurrence of spasticity and it' grade could not be a good indicator of functional mobility after stroke. Therefore, spasticity in several cases is mild to moderate and it could not interfere with the functional performance [16].

Balance problems in the elderly are closely connected with obesity, central obesity, and general muscular fitness. In a variety of static and dynamic balance field tests, BMI is a key performance determinant. Obesity also needs more attention resources in order to maintain postural stability. When participants are forced to maintain stability during distractions, such as multitasking during daily life activities, this may result in disturbed balance [16].

The results of the current investigation showed a significant decrease in TUG of the overweight subjects of mild and moderate spasticity compared with that of obese subjects. This was agreed by Greve *et al.* (2012) who established a link between postural instability and BMI and observed obese people shifting their weight in both lateral and anteroposterior directions to maintain stability. The increase in mean pressure that the mechanoreceptors – the body's sensory receptors for pressure – are subjected to as a result of an increase in body weight is one possible explanation for this lowered sensitivity [17]. Several studies have found a dose-response association between BMI and increased functional impairment or self-reported mobility. According to these studies, a person's ability to function decreases when their BMI rises [18]. According to Kalichman *et al*. (2014), there is a curvilinear relationship between BMI and function, with individuals who are overweight or obese having higher levels of physical disability or functional decline. They identified a curvilinear link between BMI and FIM efficacy, with overweight individuals having the best efficacy and very obese individuals having the worst [18]. In another retrospective investigation, Neville *et al*. (2014) found that the severity of obesity was revealed to have the lowest FIM efficacy when compared to the other obesity groups [19].

Individuals with post-stroke balance recovery issues have been demonstrated to have greater balance control issues during silent standing, particularly in higher frequency ranges (i.e., >0.4 Hz) [20]. There is a high rate of falls among people who have had a stroke, and researchers have focused on the role of spasticity in balance control in these people [21].

Conclusion

Obese people are said to have a higher risk of falling because of their impaired balancing capacity. Furthermore, the risk of falling increases with body mass, suggesting that any weight loss, rather than a return to normal weight, could reduce risk. Obesity rehabilitation methods for stroke patients are effective.

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