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Investigation of the Relationship between Trunk Muscle Strength and Hand Grip Strength with Basic Activity Daily Living and Instrumental Activity Daily Living In Stroke Patients

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Abstract

Objective: The aim of this study is to investigate the relationship between both trunk muscle and handgrip strength with the basic daily living and instrumental activities in stroke patients.

Methods and Materials: The study included randomized 28 stroke patients (23 males, 5 females) with an average age of 52.1 ± 12.2 years old. Four outcome measures were used to evaluate all patients which are; trunk muscle strength through power track hand-held dynamometer; handgrip strength using hand dynamometer; daily living activity was measured by function independent measurement, while instrumental daily living activity was measured by Lawton's scale.

Results: The results showed that there is no significant difference between trunk muscle strength and function independent measurement on the one hand, and between trunk muscle strength and Lawton's instrumental activity of daily living on the other hand. However, there is a positive correlation between the handgrip strength and function independent measurement on the one hand, and between handgrip strength and Lawton's instrumental activity of daily living on the other hand with P-value<0,05. Regarding to the relationship between trunk muscle strength and handgrip strength, we found positive correlation with p<0,05.

Conclusion: The effect of handgrip strength on stroke patients in improving both FIM and IADL higher than the effect of trunk muscle strength on both.

Keywords: Stroke; Trunk Muscle Strength; Hand Grip Strength; Activity of Daily Living

Abbreviations

CVA: Cerebrovascular Accident Patients; HHD: Hand Held Dynamometer; IDLA: Instrumental Daily Living Activity; FIM: Functional Independence Measure;

Introduction

Stroke is one of the most common causes of death around the world, as it is responsible for 4.4 million (9%) deaths out of 50.5 million annually [1]. Furthermore, it affects influence language and discourse capacities, like sensorimotor, intellectual, and perceptual brokenness. Stroke patients experience motor dysfunction, and this defect detects through the loss of motor control or engine constraint [2,3].

The trunk represents the greater part of the weight and influences the remainder of the body exorbitantly [4]. In the focal point of the trunk, there are musculoskeletal zones of the storage compartment, pelvis, hip and proximal lower limit [5]. Many Cerebrovascular accident patients (CVA) are unable to fully control their bodies, which in numerous exercises influences their practical fitness.

The furthest point dysfunction in CVA patients is the most significant reason influencing daily exercises [6]. The motor constraint of these patients effects their typical life for a long period of time and may cause hemiplegia [7]. Hemiplegia makes functional use of the affected upper extremity difficult in daily activities [8].

CVA can prompt handicap by limiting exercises of daily living. These limitations affect furthest point tasks such as eating, drinking, dressing, doing daily tasks) or the lower furthest point like strolling, running, climbing [9]. 25-74% of CVA patients are able to keep their daily living exercises (ADL, IADL) [10,11].

As indicated by the investigation of Metin Karataş and friends, the connection among Balance and functional disability and stroke muscle strength in stroke patients; as a results, trunk flexion and prolong muscle weakness have developed in patients with unihemispheric stroke who may communicate with equalization, solidness and practical debilitation [12].

According to a study by Geert Verheyden and friends, examining the relationship between trunk performance and balance, gait and functional ability after stroke, the outcomes demonstrated that trunk execution estimations were altogether related with parity, step and practical capacity esteems [13]. In the literature, there are studies examining the relationship between trunk and daily living activities in stroke patients, but there are few studies on the relationship between trunk muscle strength and grip strength and basic daily living activities and instrumental daily living activities in patients with stroke. So the aim of this study was to investigate the relationship between trunk muscle strength and grip strength with basic daily living activities and instrumental daily living activities in stroke patients.

Methods and Materials

Subjects

The study carried out at the Neurological Department of Physiotherapy at the Pamukkale University, from September 2018 to the May 2019. This study is a non-experimental study (correlational study) on stroke patients randomized between the ages of 25 and 70 years. All 28 stroke patients had a (hemiplegia/hemiparesis). All patient with orthopaedic disorder, neurological cases dont have a stroke and patient has communication problem were excluded.

Measurements

The trunk muscle strength in stroke patients was measured using the Power Track II Commander dynamometer, the patient was in a supine position. To measure the strength of the trunk flexors, the patient in the supine position, the knees are slightly bent, the arms are extended to the side. The base of the dynamometer was placed on the thorasic vertebra T4 and the patient was asked to raise his chest from the bed to produce an isometric force against the dynamometer. Power track II was measured with a Commander dynamometer. Measurements were recorded in Newton. The muscle test defined for the dynamometer was evaluated and the maximum resistance recorded [14-16]. The study also measured the handgrip strength using Hand Held Dynamometer (HHD). The measurement was taken in the standard position where the patient is in a sitting position, shoulder adduction in neutral rotation, elbow with 90 degree flexion, forearm, and wrist in a neutral position.

Three measurements were taken through the HHD test, with a one-minute interval between the measurements [17,18].

In addition, the basic daily living activities were assessed using the functional independence scale (FIM). The scale measures physical and cognitive deficits in daily life and it assesses the extent to which patients need help and care. The scale evaluates 18 different subjects with two parts (motor and congnitive FIM) in 6 different areas (self-care, sphincter control, mobility, movement, communication and social cognition). Each subject is scored on a 7-point Likert scale (1=always in need of assistance, 7=total independent). Finally, the instrumental daily living activities were assessed using Lawton instrumental daily living activity (IADL) which was developed in 1969 by Lawton. The activities include the tasks that enable people to maintain their functions in the community and carry out household chores. The most common instrumental activities in patients with stroke including; washing clothes, shopping, household chores and traveling by public transport [15,19]. The 8 points value from A to H was used to evaluate the IADL index [20].

Statistical Analysis

The power analysis of the data collection for 28 patients was 80% at a 95% confidence level. An SPSS version 22 software was used for data analysis. Continuous variables were expressed as mean ± standard deviation, median (minimum and maximum values), and categorical variables were expressed as numbers and percentages. Data and information analysis were based on the use of two tests: independent samples t test was used to compare the quantitative data according to the affected hemisphere; and the Spearman rank correlation was used to estimate the relationship between body flexion, body extension, grip strength, functional ındependence scale and Lawtons IADL correlation. In all analyzes, $p < 0.05$ was considered statistically significant.

Results

Twenty-eight stroke patients (male-female ratio, 23:5; mean age, 52.1 ± 12.2 years; age range, 25 to 67 years; mean height, 168.1 ± 6.7 cm; mean body weight, 75.3 ± 8.7 kg , body mass indexes, 26.6 ± 2.7 kgs/ m^2; education mean duration, 4.3 years; illness duration, 2.3 years). Of all patients, 53.6% had a right-sided affected hemisphere, and 46.4% had a left-sided affected hemisphere;. 89.3% had a spastic limb position, while 10.7% had a flask. The mean age of the 28 cases was 52.

The mean duration of education. The mean trunk flexion was 109, 1, mean trunk extension was 101.2, the grip strength was 25, 9, FIM 95, 5, and Lawtons IADL was found to be 4, 4 (Table 1).

	N	X	S.S	MIN	MAX
Age	28	52,1	12,2	25,0	67,0
Hight	28	168,1	6,7	155,0	180,0
Weight	28	75,3	8,7	60,0	95,0
BMI	28	26,6	2,7	21,7	34,0
Education	28	4,3	1,0	4,0	8,0
Disease duration (Year, Month)	28	2,3	2,4	0,1	10,0
Trunk Flexion (N)	28	109,1	28,4	35,1	161,0
Trunk Extension (N)	28	101,2	27,5	32,0	146,0
Hand-Grip force (Kg)	28	25,9	9,7	7,3	49,0
FIM	28	95,5	24,0	47,0	126,0
Lawtons IADL	28	4,4	2,6	1,0	8,0

FIM: Functional Independence Scale, IDAL: Instrumental Daily Living Activities

Table 1: Demographic information of the participants.

The results showed there is no significant difference between trunk flexion and activity daily living, where the p-value between trunk flexion and FIM > 0.05. Also, the P-value between trunk Flexion and IADL (p> 0.05).

Moreover, the results revealed there is no significant difference between trunk extension and activity daily living, where the P-value between trunk extension and FIM (p> 0.05). In the same time, the P-value between trunk extension and Lawtons IADL (p> 0.05) (Table 2).

On other hand, the findings demonstrated the correlation between hand grip strength, FIM, and IADL. The factually relationship between hand grip strength and FIM (p <0.05) was found, and there was a positive correlation between hand grip strength and Lawtons IADL with P-value <0.05) (Table 2).

		Trunk Flexion	Trunk Extension	Grip Strength
FIM	Rho	0,297	0,307	**0,526**
	P	0,124	0,112	**0,004**
Lawtons IADL	Rho	0,215	0,224	**0,525**
	P	0,273	0,251	**0,004**
Trunk Extension	Rho	0,968		0,621
	P	<0,001		<0,001
Trunk Flexion	Rho		0,968	0,646
	P		<0,001	<0,001
Hand-Grip Strength	Rho	0,646	0,621	
	P	<0,001	<0,001	

Rho: Spearman rank correlation. FIM: Functional Independence Scale, IADL: Instrumental Daily Living Activities

Table 2: Trunk Flexion, Trunk Extension, Grip strength, Functional Independence Scale and Lawtons IADL Correlation table.

At last, the outcomes showed that there was a positive correlation between trunk flexion and extension (p <0.001), Finally, the outcomes showed the positive correlation between trunk flexion and extension with hand grip strength, where the P-value in both relationships less than 0.001. (p <0.001) (Table 2).

Discussion

Stroke is characterized by the sudden onset of a focal neurological deficit that lasts for more than 24 hours, often resulting in long-term disability or even death, typically caused by vascular events such as occlusion or hemorrhage [21,22]. The current study sought to explore the relationship between trunk muscle strength and handgrip strength, and their impact on basic and instrumental activities of daily living (ADLs) in stroke patients. The findings revealed that while there was no significant correlation between trunk muscle strength and the Functional Independence Measure (FIM) or Lawton's Scale, a positive relationship was identified between handgrip strength and both FIM and the Lawton Scale. This suggests that handgrip strength plays a crucial role in functional independence and engagement in ADLs. Consequently, it is recommended that both trunk muscle strength and handgrip strength be integrated into early stroke rehabilitation programs to enhance patient outcomes. Although numerous studies have examined the link between trunk function and daily activities in stroke survivors, very few have specifically addressed the combined influence of trunk muscle strength and handgrip strength on basic and instrumental ADLs. This gap highlights the need for further research in this area to better inform rehabilitation strategies.

In a study by Metin Karataş, et al. [12], which investigated the relationship between balance, functional impairment, and trunk muscle strength in stroke patients, 38 patients with unilateral hemispheric strokes and 40 healthy volunteers were examined. The results revealed no significant correlation between trunk muscle strength and both the total Functional Independence Measure (FIM) score or the FIM motor score. This finding contrasts with the results of another study by Geert [13], which explored the link between post-stroke trunk performance, balance, walking, and functional ability. Geert and his team found a significant association between trunk performance and balance, gait, and overall functional ability. The discrepancy between these two studies and the current research could be attributed to differences in methodologies. The present study utilized a dynamometer to objectively measure trunk muscle strength, whereas the previous studies relied on more subjective assessments, such as the body defect scale. This methodological divergence may explain why the current study did not observe a significant relationship between trunk muscle strength and FIM scores, highlighting the importance of measurement tools in shaping the outcomes of rehabilitation research. Stroke is defined as the abrupt onset of a focal neurological deficit lasting more than 24 hours and sometime leads to death due to presupposed vascular cause resulting from the occlusion or haemorrhage [21,22].

Trunk control is a crucial factor for performing activities of daily living (ADLs), as it plays a fundamental role in maintaining posture and facilitating mobility [23]. Previous studies have highlighted that trunk control, particularly in the early stages post-stroke, can serve as a predictor for ADL outcomes at later stages of recovery [23-26], However, these studies primarily focused on basic ADLs, such as dressing or feeding, without extending their scope to more comprehensive activities of daily living, which involve more complex physical and cognitive functions. Additionally, many of these studies concentrated solely on sitting balance, often excluding critical aspects like bed mobility, which is vital for a holistic assessment of a stroke patient's functional capacity [23,25,26]. Moreover, the timing of these assessments from stroke onset varied across studies, and no study to date has specifically addressed the predictive value of early trunk control for comprehensive ADL outcomes in stroke patients. This gap highlights the need for further investigation into the early role of trunk control in predicting broader functional recovery post-stroke [24-26].

A review by Suruliraj Karthikbabu [16], Emphasized the importance of trunk assessment and treatment in stroke rehabilitation. Their study reported that isokinetic dynamometric testing for trunk flexor and extensor strength showed impressive reliability, with the flexor muscles showing a strength value of 88%, while the extensor muscles were weaker, at 64%. This finding is consistent with our study, where we found a mean trunk extension strength value of 101.2, compared to a slightly higher mean trunk flexion strength of 109.1. Our results corroborate previous research, demonstrating a strong positive correlation between trunk flexion and extension strength in stroke patients. Importantly, our study also suggests that strengthening trunk flexion may be more effective than focusing solely on trunk extension in improving overall functional outcomes for stroke patients. These findings underscore the importance of a balanced approach to trunk rehabilitation, emphasizing the need for targeted interventions to enhance both flexor and extensor strength in order to optimize recovery and improve comprehensive ADL performance.

Soke [27], examined the relationship between postural control and hand function in individuals aged 65 years and older, finding a statistically significant, moderately positive correlation between postural control and handgrip strength. This study's findings align closely with the results of our own research, which also uncovered a moderate positive correlation between trunk muscle strength and handgrip strength in stroke patients. The connection between these two muscle groups highlights the interdependence of core stability and hand function, which is essential for both basic and instrumental activities of daily living. Previous studies have similarly supported the notion that strength in the trunk muscles can have a direct impact on the performance of hand functions, underlining the importance of a comprehensive approach to rehabilitation that addresses both trunk stability and grip strength. Our study, consistent with these findings, reinforces the concept that strengthening both trunk muscles and handgrip strength should be a key focus in the rehabilitation process, particularly in stroke patients, to improve overall functional independence. The moderate level of correlation between these two factors observed in our study further emphasizes the need for an integrated therapeutic approach targeting multiple muscle groups to enhance functional recovery post-stroke.

Studies on upper extremity dysfunction following stroke have consistently highlighted its significant impact on functional recovery. In the acute phase of cerebrovascular accidents (CVAs), dysfunction in the upper extremity is observed in approximately 85% of patients [28], Even after 3-6 months, 55-75% of patients continue to experience difficulties with upper limb function [29], making it a major limiting factor in performing activities of daily living (ADLs) for stroke survivors [6]. The extent of paresis and loss of upper extremity function is striking, with up to 88% of patients showing severe impairment within the first three weeks post-stroke, and 73% still affected after six months [30,31]. Grip strength, in particular, has been widely recognized as a reliable measure for assessing the severity of paralysis and

the success of stroke rehabilitation [30,31]. Its validity as an indicator of recovery has been well-established, providing a clear link between hand function and overall functional ability in stroke patients.

In a related study, Pui Chi Cheng [32], found that handgrip strength could also serve as a tool for nutritional assessment, with stronger grip strength being associated with greater ADL independence, particularly in females. This relationship underscores the multifaceted role of grip strength in both functional and nutritional health outcomes post-stroke. Similarly, Jung Hyun Bae, et al. [33], reported a statistically significant positive correlation between daily living activities and pinch grip strength in stroke patients. Their study highlighted differences between the affected and unaffected hands in both left and right hemiplegic patients, further emphasizing the role of hand function in overall recovery.

While our study aligned with some of these findings, a notable difference lies in the study design. Unlike previous research that compared two groups (e.g., left vs. right hemiplegic patients), we focused on a single group of stroke patients. Interestingly, our findings showed no significant difference in the average grip strength values based on the affected hemisphere, with mean values of 24.08 for the left side and 27.5 for the right side. However, despite this lack of hemispheric difference, we found a statistically significant positive correlation between handgrip strength and the Functional Independence Measure (FIM), which further supports the critical role of grip strength in functional recovery post-stroke. These findings reinforce the importance of assessing and strengthening handgrip function in stroke rehabilitation, as it plays a key role in improving overall independence and quality of life for stroke survivors.

The measurement of Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) has long been recognized as a critical component in stroke rehabilitation and recovery assessment [34]. Some researchers have suggested the combination of basic ADLs and IADLs for a more comprehensive evaluation of a patient's functional ability [35,36], while Spector and Fleishman [37], argued that integrating both ADLs and IADLs enhances the precision of measurements and provides a more accurate reflection of a patient's overall functional status. Despite the importance of these measures, findings on their relationship with stroke recovery have been varied. Haaland [38], assessed the link between IADLs and arm use in patients with unilateral stroke, but they found no significant group differences in arm use related to age or IADL performance. This contrasts with our findings, where we observed a statistically significant positive correlation between handgrip strength and Lawton's IADL index. The discrepancy between Haaland's results and ours can be partly attributed to differences in measurement tools. Haaland, et al. [38] used the trunk impairment scale, while our study employed more precise instruments, such as power track dynamometry for trunk muscle strength and handheld dynamometry for grip strength. These objective measures may account for the differences in results, as our study found stronger correlations between handgrip strength and IADL performance, reinforcing the importance of objective strength assessments in stroke rehabilitation.

In our current study, we observed that trunk muscle strength was not correlated with the Functional Independence Measure (FIM) or IADL in stroke patients, suggesting that trunk strength may not directly influence overall functional independence or complex daily activities. Additionally, we found that strengthening of trunk flexors was more effective than strengthening trunk extensors in improving stroke patients' functional outcomes. These findings align with previous literature emphasizing the importance of muscle-specific rehabilitation. Furthermore, while trunk muscle strength did not correlate with FIM or IADL in our study, handgrip strength was positively correlated with both FIM and Lawton's IADL index, highlighting the critical role of hand function in overall recovery. This underscores the need for targeted rehabilitation strategies that focus not only on core strength but also on handgrip strength to improve functional independence and the ability to perform both basic and instrumental ADLs in stroke survivors.

As a result of the current study which focused on the relationship between trunk muscle strength and handgrip strength with basic daily activities and instrumental daily living activities in stroke patients. The results displayed there is no significant relationship between trunk muscle strength on the one hand and FIM and Lawton's Scale on the other hand. However, a positive relationship was found between handgrip strength, FIM, and Lawton Scale. Therefore, trunk muscle strength and grip strength should be included in the stroke rehabilitation program in the early period of the stroke.

There are many studies in the literature talking about the relationship between the trunk and the activities of daily living in stroke patients. However, few of them are talking about the relationship between trunk muscle strength and grip strength with basic daily living activities and instrumental activities of daily living for those patients. Studies on the relationship between trunk muscle strength and grip strength with basic daily living activities and instrumental activities of daily living in stroke patients are almost non-existent.

In the study of Metin Karataş and his friends, which they examined the relationship between balance and functional

impairment and trunk muscle strength in stroke Patients, they examined 38 unihemispheric stroke patients and 40 healthy volunteers. They found that trunk muscle strength was not correlated with FIM total score and FIM motor score [12].

Another study conducted by Geert et al, which they estimated the relationship between post-stroke trunk performance with balance, walking and functional ability, they revealed that trunk performance was significantly associated with balance, gait and functional ability values [13].

The current study uses a dynamometer while the previous studies were used the field subjective measurements such as the body defect scale. Therefore, the difference in the results was between the current study and previous studies, as our studies showed that there is no significant relationship between trunk muscle strength and FIM. Trunk control is an essential component to perform ADL (Activity of daily living) [23]. Previous studies found that the trunk control or sitting balance in the early stage could predict ADL outcome at a late stage in patients after a stroke [23-26]. However, the ADL function examined in the previous studies include the only basic ADL and not comprehensive ADL.

Several studies addressed only sitting balance without including bed mobility for stroke patients [23,25,26]. Furthermore, the observations of previous studies were not timed from stroke onset. To the best of our knowledge, the significance of trunk control at an early stage after stroke to predict comprehensive ADL outcome has not been investigated [24-26].

A review study conducted by Suruliraj Karthikbabu, et al. [16] which reported the assessment and treatment of the trunk in stroke patients. They found the isokinetic dynamometric testing for trunk flexor and extensor strength was 88% and 64%, respectively. Therefore, they reported that the extensor muscle strength weaker than flexors muscle [16].

In our study, the mean trunk extension value was 101.2, while the mean trunk flexion value was 109.1. Previous work was consistent with our study. There is a strong positive correlation between trunk flexion and extension values in patients with stroke. Trunk flexion strengthening is more effective than trunk extension strengthening for the stroke patients.

Soke, et al. [27] examined the relationship between postural control and hand function in the subjects age 65 years and over. They found a statistically significant moderately positive correlation between postural control and hand grip strength. The results of the previous study matched ours, there is a positive mid-level correlation between trunk muscle strength and hand grip strength. Previous studies support our work. In our study, we founded a moderate positive relationship was found between trunk muscle strength and hand grip strength. In the studies performed on the upper extremity, the dysfunction in 85% of acute stage CVA patients were observed [28]. After 3-6 months from CVA, 55-75% of patients still have problems in the upper extremity [29]. Upper extremity dysfunction is the major reason limiting daily living activities in patients with stroke [6].

The level of paresis in upper extremity loss of function is 88% and 73% after 3 weeks and 6 months of stroke, respectively. Grip strength is useful in determining the level of paralysis (Lang et al.2013, Heller 1987), and it can be used as an indicator of the success of treating stroke patients, its reliability and validity has been confirmed in previous studies [31]. Pui Chi Cheng, reported that a hand grip strength can be used as a nutritional assessment tool. They found that the ability to eat is related to handgrip strength, which was presented in females more than males and so stronger handgrip strength was correlated with greater ADL independence in females [32].

Jung Hyun Bae and colleagues reported the relationship between daily living activities and pinch grip in stroke patients. The results showed statistically significant positive correlation between the affected non-dominant hand in the left hemiplegic patient group and the grip strength of the unaffected non-dominant hand in the right hemiplegic patient group [33].

The above-mentioned result some findings were obtained in current study. This difference is due to the fact that their study compared between two groups, but in our study we used one group. However, the average values of grip strength did not differ according to the affected hemisphere, where the mean value is 24.08 on the left side, and it is 27.5 on the right side. Therefore, a statistically significant positive correlation was found between hand grip strength and FIM.

In the literature, ADL and IADL have been suggested as the main measurements to be performed after stroke [34]. Some researchers suggested to combine between basic ADL and IADL for measuring the ADL function [35,36]. According to Spector and Fleishman, combining IADL and ADL provided the precision of the measurements and increase in the ratio [37].

Haaland, et al. evaluated the relationship between instrumental daily living activities (IADL) and arm use in patients with unilateral stroke. As a result of IADL measurements, no significant group differences found with the use of both arms and age [38].

The difference between their results and our study because previous studies used the trunk impairment scale, while our study used power track denamometry to measure trunk muscle strengthening and hand held dynamometry to measure hand grip muscle strengthening. In our results, Lawton's IADL index is 4.4 and there is a statistically significant positive correlation between hand grip strength and Lawton's IADL.

In the current study, indicate trunk muscle strength is not correlated with FIM and IADL in stroke patients. In patients with stroke strengthening of trunk flexion found greater than strengthening of trunk extensor. Moreover, the grip is correlated with FIM and there is a positive correlation between hand grip strength and Lawton's IADL.

Limitation

- Difficulty to find any study about trunk muscle strength and its relationship or effect on or with IADL.
- Accessing and obtaining the Power Track II Commander device was difficult due to its high cost.
- Difficulty to accept patients to deal and Evaluate with the Power Track II Commander device.

Conclusion

The results of current study clearly showed that trunk muscle strength is not correlating with FIM and IADL, while the handgrip is correlated with FIM and IADL in stroke patients. Based on the results of our study, the following suggestions can made to academicians and clinicians interested in stroke rehabilitation.

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