Research Paper

Impaired Upper Limb Motor Function in Post-stroke Patients and Its Impact on Trunk Control and Mobility: A Cross-sectional Study

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Citation Sattar E, Ahmad U, Rehman M, Adnan M, Rehman AU, Shahid I, Abdullah. Impaired Upper Limb Motor Function in Post-stroke Patients and Its Impact on Trunk Control and Mobility: A Cross-sectional Study. Iranian Rehabilitation Journal. 2023; 21(2):283-290. http://dx.doi.org/10.32598/irj.21.2.1834.1

http://dx.doi.org/10.32598/irj.21.2.1834.1

Article info:
Received: 17 Jun 2022
Accepted: 06 May 2023
Available Online: 01 Jun 2023

Keywords:
Upper extremity, Motor skills, Stroke, Torso, Mobility limitation

ABSTRACT

Objectives: This study aims to investigate the impact of impaired upper limb motor function on trunk control and mobility in chronic post-stroke survivors so that the upper limb function should be enhanced as a core component of rehabilitation.

Methods: This analytical cross-sectional study was conducted from March 2021 to August 2021 at the Rehabilitation Center for the Physically Disabled in Peshawar, Pakistan. A total of 166 chronic stroke patients in the age range of 35 to 70 years and greater than 6 months post-stroke were included. To assess the impaired upper extremity, the Fugl-Meyer assessment upper extremity scale was used, and the trunk control and mobility were checked through functional reach test and timed up and go test, respectively.

Results: Among 166 stroke survivors having upper extremity impairment, 109(65.7%) participants' upper extremity was severely affected. Mobility levels measured through the timed up and go test were categorized and scored; accordingly, the participants showed a low risk of 22(13.3%), moderate 32(19.3%), high 72(43.4%), and very high risk of falls of 40(24%). Among 166 patients, 147(88.6%) had no trunk control which resulted in 8 times greater fall risk in 65(39.2%) participants. Thus, upper limb impairment is significantly associated with impaired trunk control and mobility (P=0.001).

Discussion: This study found about one-third of stroke survivors have a risk of falling, two-thirds have upper extremity impairment, and two-thirds have no trunk control. This study showed a significant reduction in mobility level, balance, and posture balance in stroke survivors having upper extremity impairment. These findings suggest that stroke survivors with upper extremity impairment may use therapeutic intervention to minimize falls and enhance postural balance and trunk control.

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Highlights

• There is a significant association between upper extremity impairment and trunk control in post-stroke patients.

• A strong significant association was found between upper extremity impairment and the risk of falls in post-stroke patients.

• The upper extremity impairment and level of mobility were significantly associated with post-stroke patients.

Plain Language Summary

Stroke survivors face many complications, such as motor impairment, trunk control, abnormal sensation, and balance loss which causes limitations in their daily life activities. Motor impairment limits their walking ability, and social participation, thereby decreasing their chances of returning to professional work. After-stroke trunk control is an important early predictor of daily life activities. In addition, about one-fifth of stroke survivors have a marked decrease in mobility. This study analyzed 166 patients to find the impact of impaired upper limb motor function on trunk control and mobility in chronic post-stroke patients so that the upper limb function should be enhanced as a core component of rehabilitation. The result of this study showed that upper limb impairment in stroke patients is significantly associated with impaired trunk control, risk of falls, and mobility. Furthermore, these findings suggest that stroke survivors with upper extremity impairment may use therapeutic intervention to minimize falls and enhance postural balance and trunk control.

Introduction

Stroke is a major cause of illness globally. Each year, around 800000 patients suffer from strokes. Paralysis resulting from a stroke causes disability in stroke patients and most patients have difficulty walking [1]. Over the last 3 decades, the burden of stroke is increasing in adults in the age range of 20 to 64 years [2]. Most people who had a stroke face many complications, such as the loss of motor power in muscles along with the sensation and balance loss which causes limitations in their daily life activities [3]. Immediately after the stroke, patients have weakness in their arm which does not resolve when spasticity sets after a few weeks or months, thereby further increasing the limitations with time and making treatment difficult [3]. Arm and hand movements are used in most common daily tasks [4]. A study of functional magnetic resonance imaging (fMRI) of subjects who recovered from hemiparetic stroke found that hemiparesis of the contralateral upper limb is the most common deficit after stroke, as it is experienced acutely in more than 80% of patients having stroke conditions. Meanwhile, more than 40% of stroke patients experience this disorder chronically [5]. Trunk control is the ability to remain upright during functional activities [6] Common impairment in postural balance occurs after a stroke and this postural impairment results in a fall [7]. After a stroke, trunk control is an important early predictor of daily life activities [8]. One study analyzed the swinging of arms during walking and according to the data, they concluded that during walking, gross movements are present in the shoulder, i.e. arm swing during gait occurs because of active muscle action and it is not a passive activity [9]. Another study conducted by Ortega et al. on the contribution of arms to the stability of gait concluded that arm swing contributes to lateral stabilization [10, 11]. The upper limb also helps in the recovery of balance after perturbation [12]. Also, it was observed in a study that individuals who are at risk of falls normally adopt a guarded posture after perturbation [13, 14]. During balance disturbance, individuals suddenly expand their arms to improve the stability of posture [15, 16]. Consequently, the developing literature on the impact of arms on postural balance, limiting arm movements will reduce the performance in mobility dynamic control of posture and during standing on a balance board the balance recovery is also impaired [17-20]. All outcomes show that the upper limbs have an important and significant influence on dynamic balance [21]. According to Patel et al., during static tandem standing, the mechanism of reducing postural sway is impaired when upper limb movements were restricted [21]. Due to a lack of past research, a further understanding can be obtained by measuring the impact of restricting arm movements on daily balance task performance which is commonly recommended with increasing task difficulty. Consequently, a recent research aimed to find

out the effect of limiting or allowing movements of arms on postural sway during static standing tasks of different levels of difficulty [22].

According to an evidence, a number of studies showed a large number of studies showed the impact of lower limb function on postural balance, but only very limited evidence has shown the impact of upper limb motor function on postural balance [15]. This study aims to identify the impact of upper limb motor function impairment on trunk control and mobility in chronic post-stroke patients so that the upper limb function should be enhanced as a core component of rehabilitation.

Materials and Methods

A cross-sectional study was conducted from March 2021 to August 2021 in the Rehabilitation Center for the Physically Disabled in Peshawar, Pakistan. A total of 166 samples were calculated via the Rao Soft (online sample size calculator) with a 5% margin of error, a confidence level of 95%, a population size of 289, and a response distribution of 50%. The subjects were recruited through the convenience sampling technique. The inclusion criteria were as follows: Both genders in the age range of 35 to 70 years; being a post-stroke survivor; having chronic post-stroke survivor (after 24 weeks or 6 months); being of both known cases of ischemic and hemorrhagic stroke; being able to walk independently (without an assistive device); and scoring 21 or more on the Fugl-Meyer assessment-LE scale. The exclusion criteria were being a patient with a history of total knee replacement and total hip replacement surgery in the past 1 year; being a patient with diagnosed neurological disease other than strokes, such as the cognitive or perceptual deficit, multiple strokes, cerebellar lesions, visual field loss, diplopia, vertigo, dizziness; and having any acute medical illness and patients with amputations.

Upon the approval of the advanced studies & research board along with the ethical review board of Khyber Medical University Peshawar, Pakistan, the data was collected from rehabilitation center for the physically disabled. before data collection, permission was taken from the chief executive officer of the rehabilitation center for the physically disabled. An information document was provided to the stroke survivors who fulfilled the eligibility criteria and gave consent to participate in the study. To assess the impaired upper extremity (UE) and lower extremity (LE) motor function, the Fugl-Meyer Assessment (FMA) scale was used. The Fugl-Meyer Assessment-UE scale (FMA-UE) comprises 33 items, according to which upper limb motor function was assessed, the while Fugl-Meyer assessment-LE scale consists of 17 items, and its validity and reliability is shown by a study which demonstrates the sensitivity of 77% and specificity of 89% [23]. Patients scoring less than 28 on the FMA-UE scale indicated severe upper limb impairment. A study shows the reliability of this scale by interclass correlation coefficient at 0.95 and high concurrent validity with r=0.94-0.95 [23, 24]. For the trunk control assessment, a functional reach test was performed and mobility was checked through the time up and go test and the questionnaire was filled accordingly. All the evaluation tests were carried out by an experienced physical therapist who specialized in neurological physical therapy. All the subjects were assessed in the physical therapy outpatient department. After data collection, the data were analyzed via the SPSS software, version 25. The frequency and percentage were calculated for categorical data. The chi-square test was applied to find out the association among categorical variables.

Results

A total of 166 patients with a mean age of 53.0±8.3 years participated in this study, out of which the reporting ischemic stroke prevalence was more than hemorrhagic, i.e. 71.7% vs 28.3%. The maximum number of stroke patients who had severe UE impairment was equal to n=109 (65.7%). A total of 166 stroke participants having UE impairment are reported in different categories of risk fall, that is, low risk of fall n=18 (10.8%), and individuals having 8 times greater fall risk were n=65 (39.2%). The highest number of stroke patients was n=147 (88.6%) with no trunk control. The patients were checked for mobility level on the bases of the time-up and go test, the maximum number of patients reported a high risk of falls at n=72 (43.4%) (Table 1).

The chi-square test was performed to assess the association between UE impairment and trunk control. There was a significant association between UE impairment and trunk control (P=0.001) (Table 2). Similarly, the association between UE impairment and the risk of falls was assessed by the chi-square test. A significant association was observed between UE impairment and the risk of falls (P=0.001) (Table 2). As mentioned in (Table 3), there was a significant association between UE impairment and level of mobility (P=0.001).

Discussion

The objectives of the present study were to investigate the effect of the impaired upper limb in post-stroke patients and its impact on trunk control and mobility. The present

Table 1. Patients' characteristics (n=166)

Variables		Mean±SD/No. (%)
Age (y)		53.0±8.3
Type of stroke	Ischemic	119(71.7)
	Hemorrhagic	47(28.3)
Level of upper extremity impairment[b]	Mild	30(18.0)
	Moderate	27(16.3)
	Severe	109(65.7)
Risk of fall[a]	Low risk	18(10.8)
	2 times greater risk	35(21)
	4 times greater risk	35(21)
	8 times greater risk	65(39.2)
Trunk control[b]	No	147(88.6)
	Yes	19(11.4)
Level of mobility[c]	Very high risk of fall	40(24)
	High risk of fall	72(43.4)
	Moderate risk of fall	32(19.3)
	Low risk of fall	22(13.3)

[a]Measured on Fugl-Meyer assessment scale, [b]Functional reach test, [c]Time up and go test.

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study showed that individuals having UE impairment and risk of falls are in different categories, i.e. low risk of fall at 10.8% and greater risk of fall at 39.2%. Among all the participants, 88.6% had no trunk control and 11.4% had trunk control. Their level of mobility was checked through the time up and go test showed that 13% of the participants have a high mobility level and low risk of falls while 43% have a low mobility level and high risk of falls. Somewhat similar to the present study, a study from Northwestern University, Chicago, USA in 2018 showed a 28% prevalence of falls in subjects having upper limb loss and also contributing factors of frequent falls, which show

Table 2. Association of upper extremity impairment with trunk control and risk of fall

Variables		Level of Upper Extremity Impairment			P[a]
		Severe	Moderate	Mild	
Trunk control	No	105	20	22	0.001
	Yes	4	7	8	
Risk of fall	Low risk	3	7	8	0.001
	2 times greater risk	16	8	11	
	4 times greater risk	38	6	4	
	8 times greater risk	52	7	7	

[a]Chi-square test and significant level at P<0.05.

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Table 3. Association upper extremity impairment and level of mobility

Level of Upper Extremity Impairment	Level of Mobility on Bases of Time Up and Go Test/Risk of Fall				Total
	Very High	High	Moderate	Low	
Severe	35	52	19	3	109
Moderate	2	10	9	6	27
Mild	3	10	4	13	30
Total	40	72	32	22	166
P[a]			0.001		

[a]Chi-square test and the significant level at P<0.05.

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that upper limb loss proximally at the wrist have a greater number of falls. Some of them fell once while others fell twice. The study showed that about 70% of falls occur in a person with upper limb loss, cause of falls may be slips, trips, loss of balance, occur outside the environment, while not using stairs [25]. A Dutch study showed that in the injury surveillance system, where researcher records injuries treated at the emergency department along with in a follow-up study conducted in the year between 2003 and 2007, the frequency of single fall is most commonly found in older adults (about 33%) [26] and among stroke survivors, the ratio is about 40% [27, 28].

The present study found associations between UE impairment, trunk control, risk of falls, and 65% of the population have severe UE impairment, 63% have no trunk control, 39.2% have 8 times greater risk of falls, while patients having low mobility level have 43% high risk of fall (P=0.001) which shows a strong association between them. In line with our study, research from the University of Gothenburg, Sweden, used a cross-sectional study design using data from chronic stroke patients [29]. The data from the participants were taken from two data sources, namely a study by Carvalho et al. [30] and the Gothenburg very early supported discharge (GOTVED) [31]. The study shows that the UE affected post-stroke individuals and strongly correlates with postural control. Meanwhile, the Berg balance scale and time up and go test were used and showed a strong association between UE impairment and loss of postural balance. Berg balance scale showed that 21% have impaired balance while the time up and go test showed that 27% have impaired balance. Among all the participants, 5 patients were unable to participate in the time up and go test and were categorized as impaired balance. The patients who reported problems of postural balance were older than other patients who do not report any postural impairment. The study also reported better function of the UE measured by the Fugl Mayer test and showed that it strongly correlated with a good balance of posture [32].

The current study also demonstrated decreased mobility level and speed of walk checked through time up and go test, where patients having severe upper limb impairment were having more low mobility level and increased fall risk as compared to individuals having mild upper limb impairment. Hong et al. (2020) reported a decrease in gait speed and step length when elbows are immobilized at 30, 90, or 120 degrees, and were having fixed orthosis while walking [33]. Moreover, in India, a study conducted in 2014 also exhibited a good association between upper and lower limbs' motor function level and balance. Meanwhile, the Berg balance scale items showed a good correlation with the components of the Fugl Meyer assessment UE scale [34]. This study is also in line with our research but shows a moderate correlation between impaired upper extremities and balance, the trunk control was not assessed, and the sample size was also very small (n=44 patients).

Our study showed that upper limb impairment can also be a risk factor in chronic post-stroke patients and can affect their mobility level. Among the studies that are in line with our research, a prospective cohort study was carried out and the mobility level was assessed by the river mead mobility index in the first and third year in the post-stroke period, and the decline was determined by >2 points on resonance magnetic image. Results show a decline in the status of mobility in about 21% of the population [35]. Most patients with UE impairment are unable to perform their daily life work normally and cannot participate in social activities because they do not achieve full recovery of their paralyzed arm [9]. This study also showed that patients were having severe upper limb impairment and decreased motor function assessed through the Fugl-Meyer assessment UE scale and it affected their daily life work.

Our study also showed a positive association between upper limb impairment and trunk control i.e. out of 109 patients having severe upper limb impairment, 105 patients' trunk control was also affected and their risk of falls was also high. A study in 2010 was conducted on 26 hemiplegic patients (11 men, 15 women) with shoulder subluxation, their balance was checked with and without wearing an arm sling. The results showed that the functional reach test was performed better with an arm sling which reduced the possible arm swing [36]. A study in 2014 states that the relationship between UE spasticity and balance presented that upper limb spasticity results in decreased balance confidence which contributes to an increased fear of falling [37]. This study also showed that patients having severe UE impairment have greater fall risk as compared to individuals having moderate or mild UE impairment.

Study limitations

In the present study, we gathered very limited data, because of the COVID-19 pandemic. Access to patients was difficult. This was a single-centered study, thus the sample size was small. Also, the pre-stroke mobility level and health status of patients may have affected their mobility and trunk control.

Recommendations

It is further recommended to carry out such studies on large populations in well-established rehabilitation centers and randomized controlled trials or other interventional studies should be carried out to find out the effect of upper limb impairment on balance and lower limb improvement. Proper attention should also be given to the early improvement of upper limb motor control to minimize falls and enhance balance.

Conclusion

This study found that about one-third of stroke, survivors have a risk of falling, two-thirds have UE impairment, and two-thirds have no trunk control. This study also demonstrated a significant reduction in mobility level, balance, and posture balance in stroke survivors having UE impairment. Thereover, it should be of clinical importance that LE impairment affects balance and posture, and the UE is affected by it. These findings suggest that a person with UE impairment may use therapeutic intervention to maximize postural balance. Furthermore, these findings suggest that a person have UE impairment may get benefits from regular monitoring and therapy by clinicians and go through targeted physical therapy to minimize falls and enhance postural balance and trunk control.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Advanced Studies and Research Board (ASRB) and the Ethics Review Board of Khyber Medical University Peshawar (Code: KMU(IPM&R)/MSPT/2020/33258) and informed written consent has been obtained from individuals.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Conceptualization and methodology: Erum Sattar; Investigation: Muheebur Rehman and Muhammad Adnan; Writing-original draft: Erum Sattar and Irum Shahid; Writing-review & editing: Uzair Ahmad and Subhan ur Rehman; Resources: Abdullah.

Conflict of interest

The authors declared no conflict of interest.

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