

# Research Paper: Comparison of Effects of Bilateral Versus Unilateral Quadriceps Training on Balance, Functional Mobility and Functional Gait in Patients With Stroke



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**Citation:** Rastogi S, Hamdani N. Comparison of Effects of Bilateral Versus Unilateral Quadriceps Training on Balance, Functional Mobility and Functional Gait in Patients With Stroke. Iranian Rehabilitation Journal. 2017; 15(1):43-48. <https://doi.org/10.18869/nrip.irj.15.1.43>

**doi:** <https://doi.org/10.18869/nrip.irj.15.1.43>

## Article info:

**Received:** 10 Sep. 2016

**Accepted:** 26 Dec. 2016

## Keywords:

Progressive resistive training,  
Quadriceps, Stroke

## ABSTRACT

**Objectives:** Motor weakness is a notable symptom after stroke. Hence, the aim of this study was to find out the effect of bilateral quadriceps training compared to that of unilateral quadriceps training on balance, functional mobility and functional gait in patients with stroke. **Subjects:** Male and female hemiparetic patients between 40-60 years of age with post-stroke of 1-6 months were included in the study. **Study Design:** Test re-test was performed.

**Methods:** Data was obtained through strain gauge, Berg balance scale, dynamic gait index and timed up and go test, and then again, data was obtained with the help of the above-mentioned instruments 6 weeks after providing the patient with strength training.

**Results:** Functional mobility and isometric strength of unaffected side gave significant values and balance, functional gait and isometric strength on affected side gave insignificant values.

**Discussion:** The findings of the present study suggested that bilateral quadriceps training is good to improve functional performances like timed up and go test and isometric strength on the unaffected side. However, to improve further, the Berg balance scale, dynamic gait index and isometric strength scores of affected side, for both the bilateral quadriceps and unilateral quadriceps training, are equally effective.

## 1. Introduction

Studies have been conducted on the relationship between whole lower extremity muscle strength, balance, functional gait and functional mobility [1-3]. However, only a few studies have focused on knee extensor muscle strength correlation with functional performances like balance, mobility

and gait. The knee extensor muscle is an important contributor to human locomotor efficiency and stability and is crucial to a variety of other ADL too. So, the extension of the leg is an important movement involved in daily life [4-6].

Few researches have been conducted on the effects of unilateral quadriceps training on balance, functional mobility, and functional gait in patients with stroke [7, 8].

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Specifically, deficits are well recognized in both paretic and non-paretic limbs. Bilateral training in which the patient practices identical activities with both of the limbs has been proposed to improve hemiplegic limb control and function. Regulation of bilateral, identical, and synchronous movements appears to be coordinated centrally through bilaterally distributed neural networks connected via the corpus callosum, involving cortical and subcortical areas. These networks stipulate a shared facilitatory drive to both motor cortices, contributing to a sound spatial coupling of limb movement noticed during bilateral, identical, synchronous, and voluntary movements.

Hence, the beneficial effects of bilateral training in stroke are assumed to arise from this coupling effect in which the nonparetic limb provides a template for the paretic limb in terms of movement characteristics, facilitating restoration of movement [9, 10]. This study is aimed to find out the effect of bilateral quadriceps training compared to the unilateral quadriceps training on balance, functional mobility, and functional gait in patients with stroke.

## 2. Methods

A total of 30 subjects were selected by random sampling based on inclusion and exclusion criteria. All the patients were recruited from the inpatient and outpatient department of HAHCH, Jamia Hamdard New Delhi.

### Subjects

Inclusion criteria: Male/female between 40-60 years of age; hemiparetic patients with post-stroke of 1-6 months; patients having ischemic stroke or hemorrhagic stroke (Unilateral stroke); patients who were able to follow verbal commands or demonstrated directions, which ensured that each patient was trainable (MMSE $\geq$ 24); Berg balance scale less than 45/56; motricity index of score as 25 points, i.e. movement against gravity was taken into account.

Exclusion criteria: Brain tumors associated with CVA; patients having another mobility limiting neurological condition (e.g. dementia or Parkinson's disease) or any etiology of trauma or any identified orthopedic condition (Osteoporosis, RA, OA); and patient having serious uncontrolled medical complications.

### Procedure

Subjects were selected according to the inclusion and exclusion criteria. Informed consent was obtained from each patient before confirming their participation in the study. On the first visit, data in the form of scores was ob-

tained through Berg balance scale, dynamic gait index, timed up and go test, and strain gauge. Then data was obtained with the help of the above-mentioned scales and strain gauge 6 weeks after providing the patient with strength training. Group A consisted of patients who got unilateral training, and Group B consisted of patients who got bilateral training. Firstly, the isometric muscle strength was measured with strain gauge.

The patients were made to sit in a high sitting position on quadriceps table and made to push one side of distal arm of quadriceps table in the forward direction (extension of leg). The other side of the distal arm of quadriceps table was attached to the ring of chain. The chain was attached to strain gauge's ring through a hook. Finally, the strain gauge's other ring was attached to a hook, which was further attached by a chain to the rod that was tied to the posterior legs of quadriceps table. The subject was allowed 5 seconds to develop the maximum contraction. This was done to prevent a sudden snatching effort and also prevent a prolonged effort of more than 5 seconds at the end of which the subject merely would maintain his maximum effort rather than increase it. The average of three successive measurements was taken at intervals of one minute and again after 6 weeks of successful completion of the treatment protocol. Three other successive measurements were also taken accordingly.

### Training program

The subjects were made to participate in a supervised strength training three times a week for 6 weeks. In each training session, the knee extension progressive resistance exercises were performed. In one-half of the subjects, bilateral training was performed while in another group, exercises were performed unilaterally. In bilateral training, the affected one was first trained followed by training of the unaffected one.

During the first 2 weeks of the training, the subjects were trained with the loads of 50% of 1 RM. Twelve repetitions were performed per set and total sets were four. During the second two weeks of training, the subjects were trained with the loads of 70% of 1 RM. Eight repetitions were performed per set, and the total sets were five. During the last two weeks of the training, the subjects were trained with the loads of 80% of 1RM. Six repetitions were performed per set, and the total sets were six [11].

### Data Analysis

Statistical analysis was done using SPSS Software. Independent t-test was used to compare the impacts of bi-

lateral against unilateral quadriceps training on balance, functional mobility, and functional gait of the patients with stroke. Student's t-test was used to compare isometric strength, Berg balance scale, dynamic gait index and timed up and go test values in both of the groups after training of 6 weeks. A significance level of 0.05 was used for all statistical comparisons.

### 3. Results

The study consisted of two groups. Group 1 comprised of unilateral training patients, which had 10 males and 3 females with a mean age of 52.62 years while group 2 had 12 males and 3 females with a mean age of 49.60 years. Each patient's age, duration since onset, MMSE, and weight was recorded. Table 1, 2 gives the details of the mean and standard deviations of these scores. These variables had no significant difference between the two groups. Increase in pre values to post values for isometric strength of affected side, Berg balance scale and dynamic gait index showed no significant difference while timed up and go test and isometric strength of unaffected side showed a significant difference (Table 3 and 4).

### 4. Discussion

Every parameter in the demographic data like age, gender, duration since onset, MMSE, and weight in both the group's analysis showed homogeneity.

#### Age

Age showed non-significant results. The mean age was 52.62 years with a standard deviation of 5.2 in the unilateral training group, and the mean age was 49.60 years with a standard deviation of 6.4 in the bilateral training group (Table 1). In the present study, the age for both the groups was homogeneous, indicating there was no difference in both the groups (the distribution was equal in both of them) (Table 1).

#### Duration since onset

Duration since onset showed non-significant results. The mean duration was 118.15 with a standard deviation of 44.6 in the unilateral training group, and the mean duration was 101.33 with a standard deviation of 47.5 in the bilateral training group (Table 1). The duration since onset for both of the groups came out to be of equal means with no difference in their distribution.

#### MMSE

MMSE showed non-significant results while the mean cognitive values for unilateral training group was 26.92 with a standard deviation of 1.3 and for the bilateral training group was 26.33 with a standard deviation of 1.7. MMSE values for both the groups were equally distributed (Table 1).

**Table 1.** Comparison of unilateral training group versus bilateral training group

Variable	Unilateral (n=13) Mean±SD	Bilateral (n=15) Mean±SD
Age (y)	52.62±5.2	49.60±6.4
Duration (days)	118.15±44.6	101.33±47.5
MMSE	26.92±1.3	26.33±1.7
Weight (kg)	70.92±11.10	78.53±12.78

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**Table 2.** Comparison of isometric strength, Berg balance scale, dynamic gait index and timed up and go test between two groups

T-Value	P-Value
1.342	0.191
0.960	0.346
1.006	0.324
-1.668	0.107

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**Table 3.** Comparison of post test values of isometric strength (Diff affected & Diff unaffected), Berg balance scale, dynamic gait index and timed up and go test between two groups unilateral training group versus bilateral training group

Variable	Unilateral (n=13) Mean±SD	Bilateral (n=15) Mean±SD
Diff_affected	1.24±0.46	1.49±0.93
Diff_unaffected	0.14±0.15	1.83±0.92
Diff_bbs	1.46±0.87	2.07±1.335
Diff_dgi	1.08±0.86	1.40±1.05
Diff_timed up	-1.77±1.16	-3.03±1.87

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**Table 4.** Comparison of their levels of significance

Variable	T Value	P Value
Diff_affected	-0.877	0.388
Diff_unaffected	-6.493	0.001
Diff_bbs	-1.393	0.175
Diff_dgi	-0.878	0.388
Diff_timed up	2.102	0.045

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## Weight

Weight also showed non-significant results. The unilateral training group showed a mean of 70.92 kg with a standard deviation of 11.10, and the bilateral training group showed a mean of 78.53 kg with a standard deviation of 12.78. The weight of the patients was in uniformity in both the groups. An increase in particular variables from pre values to post values was observed (Table 1 and 2).

Isometric strength on the affected side showed non-significant results. Isometric strength on affected side after bilateral training was not much improved as compared to after unilateral training (Table 3 and 4). Previous studies have also shown significant gains in the strength of affected side after 6 weeks of intervention by isokinetic strength training. Others have shown significant gains in the strength of paretic limb knee extensors when PRT was applied [5, 6, 9].

Regardless of the resistance training mode employed, the resistance exercise should focus on other impairments like non-paretic limb. Interestingly, in the contra lateral side, both changes in intrinsic muscle characteristics and impaired neural activation seemed responsible.

In the unilateral side, reduced rate of torque development seemed primarily related to neural activation changes. Hence, strengthening regimens of the paretic as well as non-paretic limbs are important [12-14].

Isometric strengthening of the unaffected side showed significant results. Isometric strength on the unaffected side for bilateral training was more effective than unilateral training (Table 3 and 4). Previous studies have also shown significant improvement on the non-paretic side strength after stroke by stating that beneficial effects in bilateral training given on unaffected side in stroke also gave a coupling effect. The non-paretic limb provided a template for paretic limb in terms of movement characteristics, facilitating restoration of movement [9].

According to this study, functional performances were found to be correlated with both of the limbs and served as indicators of impairment. Berg balance scale for bilateral training was no more effective than unilateral training. Dynamic Gait Index (DGI) showed non-significant results in both unilateral and bilateral training groups, suggesting that DGI for bilateral training was no more effective compared to unilateral training. Timed up and

go test showed significant results, suggesting its effectiveness for bilateral training than for unilateral training.

According to the results obtained in this study, two parameters, i.e., isometric strength of unaffected side and timed up and go test showed significant results in which bilateral training showed to be good. The other three parameters, i.e., isometric strength of affected side, Berg balance scale and dynamic gait index, showed insignificant results (Table 3 and 4). This proved that bilateral quadriceps training is not much effective than unilateral quadriceps training.

## 5. Conclusion

The findings of the present study suggested that bilateral quadriceps training is good for improving functional performance like timed up and go test and isometric strength on the unaffected side. For further improvement, the Berg balance scale, dynamic gait index and isometric strength scores of affected side, both for the bilateral quadriceps or unilateral quadriceps training, have been proved to be equally effective.

## Acknowledgments

We appreciate all the financial support provided by Hamdard Institute of Medical Sciences and Research, New Delhi.

## Conflict of Interest

The authors declared no conflicts of interest.

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