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Research Article

Effect Of Quadriceps Inhibition And Hamstring Facilitation On Knee Control In Hemiplegic Gait.

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ABSTRACT

Objectives: To find out the effect of conventional exercises along with quadriceps inhibition and hamstring facilitation on knee control in hemiplegic gait.

Methods: This was an experimental study where60 participants were selected according to inclusion and exclusion criteria and were randomly divided into two groups i.e. group A and B .Group A(n=30) Control, Group B(n=30) experimental group received treatment for 6 weeks for 5 days/week. Upright Motor Control Knee Flexion and Extension Test (UPMCT- KF KE) and Dynamic Gait Index (DGI) were used to assess participant's pre and post treatment.

Findings: Data was statistically analysed using Student t testfor groupA post intervention UPMCT-KF was (1.36±0.49) with *P* value 0.0003, UPMCT-KE was (1.36±0.49) with *P* value 0.0003, and DGI was (8.3±1.53) with *P* value <0.0001 which shows extremely significant. For groupB post intervention UPMCT-KF was (1.93±0.63) with P value< 0.0001, UPMCT-KE was (2±0.694) with p<0.0001, and DGI was (12.7±2.88) with P value <0.0001 which shows extremely significant.

Between group comparison UPMCT-KF for groupA shows mean difference (1.36±0.49) whereas groupB shows a significant mean difference (1.93±0.63) , UPMCT-KE for groupA shows mean difference (1.36±0.49) whereas groupB shows a significant mean difference (2±0.694), and DGI groupA shows mean difference (8.3±1.53) whereas groupB shows a significant mean difference (12.7±2.88).

Conclusion: Hamstring facilitation improves toe clearance, prevents hip hiking and reduces risk of fall. Quadriceps inhibition helps to prevent knee hyperextension. Combination of these exercises normalizes tone and achieves knee control.

Keywords : Stroke, Hemiplegic gait, Knee control, Inhibition, Facilitation.

Introduction

Stroke is defined by the World Health Organisation as "rapidly developed clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin."[1]A global systematic review of population-based stroke studies found that stroke incidence in low- and middle-income countries (LMICs) increased from 56 to 117 per 100,000 person-years from 1970-1979 to 2000-2008. In contrast, high-income countries (HICs) saw a decrease from 163 to 94 per 100,000 person-years during the same period, indicating a 42% decrease in HICs and more than a double increase in LMICs over four decades.[2]

There are two types of strokeshaemorrhagic and ischemic, with ischemia being the more prevalent.Ischemic strokes happen due to blood vessel blockage, reducing brain blood supply, while hemorrhagic strokes result from vessel ruptures, leading to intracranial bleeding. Ischemic strokes make up 62% of all cases, with hemorragic strokes accounting for 28%.[3]Some of the most common risk factors for stroke include

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hypertension, cerebral emboli, diabetes mellitus, hypercholesterolemia, physical inactivity, obesity, heredity, and smoking.[4]
Gait asymmetry is a common feature in individuals with hemiplegic gait, a walking disorder often observed in stroke survivors. Recent research emphasizes the importance of understanding the level of asymmetry over walking speed deficits, as it provides insights into the extent of walking impairment and the compensatory mechanisms used by post-stroke patients.[5]The nature of gait asymmetry differs from one patient to another; some may display reduced flexion, while others exhibit decreased extension angles in the affected lower limb. Notably, irregular muscle activity patterns during various walking phases, such as stance and swing, contribute to these asymmetry variations. This illuminates the complexities of hemiplegic gait and underscores the necessity of addressing gait asymmetry to enhance mobility and reduce the risk of falls among stroke survivors. [5,6]
Muscle strength, particularly in the knee extensors, plays a crucial role in achieving gait independence. The mechanical outcomes of these interactions manifest as observed gait impairments in conditions like stereotypical hemiplegic gait. [7] This gait pattern is typically characterized by hip extension, adduction, and medial rotation, along with knee extension, ankle plantar flexion, and inversion. Spastic muscles are activated synergistically, leading to hip and knee extension during the stance phase of walking. This abnormal activation hinders the flexion of the hip and knee, making it difficult for the foot to clear the ground during walking. [8]
One of the main goals of rehabilitation programs involves the regaining and optimizing of walking. In this study Stroke rehabilitation aims to facilitate and enhance the recovery of motor function by a combination of quadriceps inhibition and hamstring facilitation exercises on knee control in hemiplegic gait.

Weight bearing exercises are believed to prevent soft tissue tightness or contracture and restore muscle length through sustained stretching. [9]Close Kinematic Chain (CKC) exercises helps in tone normalisation. It promotes coordinated co-contraction of the agonist and antagonist muscles, resulting in normalising tone in spastic muscle groups. CKC exercise has been suggested to enhance lower extremity muscle strength.[10]Eccentric muscle training is gaining popularity since it builds muscle strength more than concentric training. Eccentric training causes more hypertrophy than concentric training. Furthermore, eccentric training can enhance muscle size and strength while consuming relatively little energy.[11]

Adequate knee flexion during mid-swing is crucial to provide enough clearance between the foot and the walking surface, preventing toe catch. In contrast, achieving full or nearly full extension at terminal swing creates an extension moment upon loading, preventing buckling and ensuring a safe transition from swing to the stance phase of gait.[12]The most common cause of gait abnormalities in hemiplegic gait is quadriceps overactivity.[8,13]

During normal gait, the locomotor centre of the Central Nervous System (CNS) maintains balanced co-activation of the agonist quadriceps and antagonist hamstring muscles in order to stabilise the knee joint during mid-stance. This balanced co-contraction control, however, is impaired in people with hemiplegic gait due to cortical disinhibition following a Central Nervous System lesion. The neuromuscular imbalance is characterised by synergistic quadriceps over-activation and reciprocal inhibition of the hamstring muscles, resulting in knee hyperextension or genu recurvatum.[14]
The majority of the studies have focused on functional restrictions rather than intrinsic neuromuscular imbalance or damage in those with hemiplegic stroke in order to correct gait abnormalities. Quadriceps inhibition exercises, in combination with hamstring facilitation exercises, may help to rectify the basic neuromuscular imbalance between spastic quadriceps and underactive hamstring. Increased proprioceptive joint and kinesthetic (movement) senses may have contributed to the healing or normalisation of neuromuscular imbalance. This improved proprioceptive input may have given accurate direction or assisted force for corrected kinematic knee joint movement patterns during dynamic locomotion in hemiplegic stroke patients.
There is currently an increasing interest in long-term stroke management. Understanding the effect of intervention such as quadriceps inhibition and hamstring facilitation exercises on knee control and gait is essential. Weight bearing exercises helps in inhibiting muscle tone and eccentric exercises improves muscle strength. In stroke patients, gait recovery is an important aim in the rehabilitation and lower extremity spasticity treatment has frequently failed to improve gait. Hence, in this study we mainly focused on both the muscle group simultaneouslyi.e, inhibiting quadriceps muscle by weight bearing exercises and facilitating hamstring muscle using eccentric contraction exercises.

METHODOLOGY

Study design: Experimental Study of Pre-and Post-Design.
A total of 60 patients diagnosed with Stroke, both males and females, within the age group of 35 to 65 years, withBrunnstrom stages 2 and above, individuals able to stand with support and UPMCT KE-KF subjects with score 1 were selected for this study. The majority of patients were residents of Karad, Maharashtra. The purpose of the study and the role of patients were clearly explained to the patients before starting the actual

study. The objectives wereto find out the effect of conventional exercises on knee control in hemiplegic gait and to find out the effect of conventional exercises along with quadriceps inhibition and hamstring facilitation on knee control in hemiplegic gait.

Outcome measures:

Upright Motor Control Test:The Upright Motor Control Test (UMCT) was originally developed for adults with stroke to assess voluntary lower limb control in the standing position, with the view of predicting ambulation level.[14]

Dynamic Gait Index Score Sheet:The Dynamic Gait Index measures mobility function and dynamic balance in walking and stair climbing. There are 8 items on the DGI and each item is scored on a 4-point scale [(3) Normal; (2) Mild impairment; (1) Moderate impairment; (0) Severe impairment] with a maximal score of 24.[15]

Procedure: After the approval from the Institutional Ethics Committee of KIMSDU, Individuals were approached and selected based on the inclusion and exclusion criteria. The procedure was explained and written informed consent was taken from those willing to participate. Demographic information of the subjects was taken. The individuals were explained the purpose of the study. Also, they were informed about the procedure. The 60 individuals were randomly allotted toboth groups, i.e., 30 in each group.Group A(n=30) Control and Group B (n=30) experimental group received treatment for 6 weeks for 5 days/week for 60 mins per session. Upright Motor Control Knee Flexion and Extension Test (UPMCT- KF KE) and Dynamic Gait Index (DGI) was used to assess participants pre-treatment.Then, the protocol was implemented as per the groups. The later post-test assessment was done by using the same outcome measures as mentioned above. Data were recorded for both groups and the values were compared to test the hypothesis and level of significance among both groups. For Group A—Conventional Group (CG), the treatment protocol includedActive assisted exercises for hip, knee and ankle joint, Pelvic bridging , Hip extension with knee flexion over the side of mat pushing down through the heel, Gait training included backward walking, side walking and obstacle walking, Stair climbing and Cycling. For Group B—Experimental Group (EG), the treatment protocol was Knee sitting to kneeling, Kneeling position: forward bending with therapeutic ball, Hamstring isometric on therapeutic ball, Quadruped position: forward reach outs, Kneeling position: Knee flexion with ball squeeze, Half kneeling to sitting, Lunges and Wall squats.

Statistical Analysis:

Statistical analysis was done manually and by using the statistics software's SPSS version 16.0. Paired t test was used for statistical analysis of pre- and post-intervention within the group. Unpaired t test was used for statistical analysis of pre- and post-intervention between the groups. The ethical code number was 115/2022-2023 which was given by the Institutional Ethics Committee.

Results:

Table No. 1 GenderDistributionintheStudy

GENDER	NOOF SUBJECTS	PERCENTAGE
MALES	37	62%
FEMALES	23	38%
TOTAL	60	100%

Table No. 2 Age Distribution

AGECATEGORY	NO.OF SUBJECT	PERCENTAGE
35-45	4	6.66%
46-55	22	36.66%
56-65	34	56.66%

Table No. 3. Comparison of mean scores of UPMCT-KF within and between both the groups

UPMCT-KF	Pre	Post	*P* value	Inference
GROUPA	1±0	1.36±0.49	0.0003	Extremelysignificant
GROUP B	1±0	1.93±0.63	<0.0001	Extremelysignificant
Inference	Not significant	Extremelysignificant		

Graph-1:

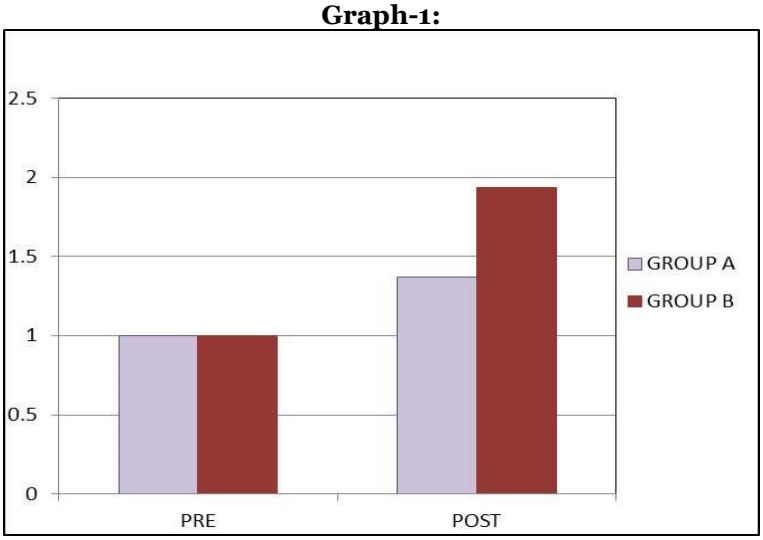


Table No. 4. Comparison of mean scores of UPMCT-KE within and between both the groups

UPMCT-KE	Pre	Post	*P* value	Inference
GROUPA	1±0	1.36±0.49	0.0003	Extremelysignificant
GROUP B	1±0	2±0.694	<0.0001	Extremelysignificant
Inference	Not significant	Extremelysignificant		

Graph-2:

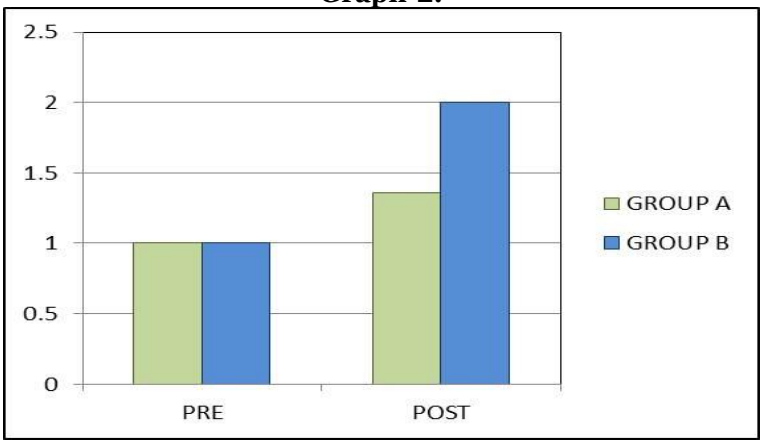
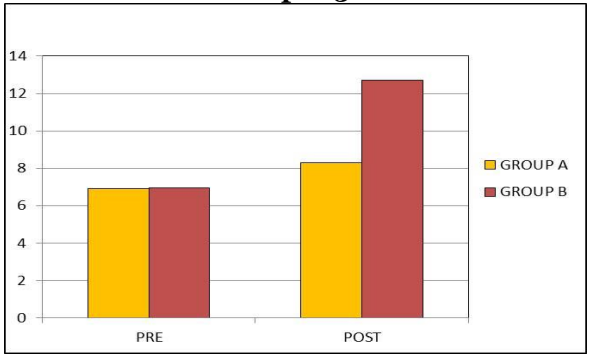


Table No. 5. Comparison of mean scores of DGI within and between both the groups

DYNAMIC GAIT INDEX	Pre	Post	*P* value	Inference
GROUPA	6.93±0.98	8.3±1.53	<0.0001	Extremelysignificant
GROUP B	6.96±1.2	12.7±2.88	<0.0001	Extremelysignificant
Inference	Not significant.	Extremelysignificant		

Graph -3:



Total of 60 subjects between the age group 35-65 years were included in the study. Out of which, 37 (62%) were males (62%) and 23 (38%) were females (38%) [Table 1]
The most commonly affected age group was 56-65 years with 34 (56.6%) subjects. There were 22 subjects (36.6%) in the age range 46-55 years, and 4 (6.6%) in the age group 35-45 years. [Table 2]
Thetable 3and fig 1 showsthat between group comparison of UPMCT-KF for group A shows post mean difference (1.37±0.49) whereas group B shows a significant post mean difference (1.93±0.62) with significant *P* value <0.0003.
Thetable 4 and fig 2 showsthat between group comparison ofUPMCT-KE for group A shows post mean difference (1.36±0.49) whereas group B shows a significant post mean difference (2±0.694)with significant *P value* <0.0001.
Thetable 5 and fig 3 showsbetween group comparison ofDGI group A shows post mean difference (8.3±1.53) whereas group B shows a significant post mean difference (12.7±2.88) with significant *P* value <0.0001.

Discussion:

The purpose of this study was to study the effect of quadriceps inhibition and hamstring facilitation exercises on knee control in individuals with hemiplegic gait. The results showed that at the end of the six weeks,the group A (control group which was given conventional exercises) andGroup B (experimentalgroup which was given conventional along with quadriceps inhibition and hamstring facilitation exercises) experienced significant improvements on knee control.
The group B (experimental) experienced greater outcomes for all variables in comparison to group A (conventional).
The objective of this review was to determine whether quadriceps inhibition and hamstring facilitation exercises applied for knee control is an effective intervention.
Stroke, a frequently encountered cerebrovascular ailment, exhibits substantial morbidity and mortality.[16] It is associated with various neurological impairments, including paralysis, motor function loss, muscle weakness (paresis), complete muscle function loss (plegia), and muscle atrophy. [17]Sridaret al. observed a decline in the kinematic and kinetic performance of poststroke patients, including decreased walking speed, quadriceps muscle moment, and quadriceps muscle power. [17] In present study, out of total 60 Stroke survivors, 37 were males and 23 females.
The selection of the knee joint was based on its vital biomechanical role in locomotion. It remains stable during the swing phase, preventing the lower limb from contacting the ground. Additionally, it facilitates smooth flexion, absorbing shock, conserving energy, and providing strength to the lower limbs.[18]
Li S in his study stated that knee extensor spasticity is commonly accepted as the primary cause. Clinical management has focused on the reduction in knee extensor spasticity. It concluded that due to overactivity of extensor muscle in lower limb there is disturbance in gait pattern, so focusing on inhibiting extensor muscle may help in improving in gait pattern.[19]
So this study mainly focused on quadriceps muscle which is knee extensor as well hamstring muscle which is knee flexor simultaneously. Knee extensor spasticity is commonly considered the primary cause of gait impairment in stroke. It is thus expected that addressing quadriceps muscle spasticity would improve gait. Hamstring muscle whose action is knee flexion goes into weakness. Muscle strength is only one of the elements necessary for smooth functioning.

Lattouf, NisrineAbdelnour et al. examined the role of eccentric exercise in strengthening muscles of the lower extremity and ultimately improving autonomy in patients with post-stroke hemiparesis during gait. Thirty-seven patients hemiparetic adults were recruited, randomized into a control group (n=19) and an intervention group receiving eccentric muscle strengthening (n=18). Study concluded that eccentric training can be useful in strengthening the muscles of the lower limbs, and promoting gait performance. Eccentric training could complement other methods of managing patients with post-stroke hemiparesis. [11]
Co-contraction of the rectus femoris muscle plays a crucial role in enhancing knee and lower limb stability in hemiplegic stroke patients. Yuan H et al. study shows a significant increase in muscle co-contraction ratio in the affected extremity compared to the unaffected one ($t=-4.066$, $P<0.05$). This ratio correlates significantly with key factors such as peak knee extension angle ($r=0.387$, $P=0.035$), Fugl-Meyer scale ($r=-0.522$, $P=0.003$), and Modified Ashworth Scale ($r=0.404$, $P=0.027$) during the stance phase of the gait cycle, emphasizing its essential role in evaluating lower extremity function in hemiplegic stroke populations.[20]

Yiyeop Moona and Youngsook Bae conducted a study in which fourteen chronic stroke participants were randomly allocated to the experimental group (n = 7) and control group (n = 7). The study concluded that experimental group showed improvement in walking ability with pre post mean values of DGI (score) 12.86 ± 2.41 and 16.00 ± 3.31 and showed increase in DGI score of 3.14 points. Whereas, this study the experimental group who were given quadriceps inhibition and hamstring facilitation exercises showed extremely significant difference with $p<0.0001$ with mean pre 6.96±1.2 and post 12.7±2.8 and showed significant increase in DGI

score of 5.1 points. It concluded that exercises which focus on both the muscles i.e., quadriceps and hamstring showed significant in gait.[21]
Task related training has shown significant improvement in walking performances over conventional exercises. It has shown positive changes in both spatial as well as temporal variables [22].
Within group comparison of pre and post intervention of outcome measures there was significant improvement noted. For upright motor control test-knee flexion there was significant difference among experimental group than in control group with significant *P*value <0.0003. For upright motor control test-knee extension there was significant difference among experimental group than in control group with significant *P*value <0.0001. For dynamic gait index there was significant difference is seen among experimental groupthan in control group with significant *P* value <0.0001.
Hence in this study, the experimental group showed significant improvement in all the parameters,Thus, the study accepts the alternate hypothesis i.e., there is significant effect of quadriceps inhibition along with hamstring facilitation exercises on knee control in individuals with hemiplegic gait.

Conclusion

In this study, based on statistical analysis, presentation, andintervention it was concluded that there was significant effect of Quadriceps inhibition along with Hamstring facilitation exercises on knee control in individuals with Hemiplegic gait.
Thus, the study provided the evidence to support thatQuadriceps inhibition and Hamstring facilitation exercises on knee control in Hemiplegic gait. Hence, Alternative Hypothesis is proven.

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Conflicts of interest: There are no conflicts of interest.

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