Closed VS. Open Kinematic Chain Exercises on Gait Performance in Subacute Stroke

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Study design

Randomized clinical trial.

Background & purpose

The goal of this prospective study was to evaluate the efficacy of open vs. closed kinematic chain exercises on gait performance in sub acute stroke patients.

Materials &methods

Thirty patients were randomly allocated in to two groups :open kinematic chain (OKC) group and closed kinematic chain (CKC) group comprising of 15 patients in each of these groups for a 5 week program. Subjects were tested on two measurement scales of functional ambulation profile (FAP) and ink footprint record method on two occasions during the study i.e. prior to the beginning of the rehabilitation program and 5 weeks after the training.

Data analysis &result

Both groups experienced a statistically significant improvement in gait performance by kinematic chain exercises though there were favorable and significant differences between the effects of open kinematic chain and closed kinematic chain exercises. Results show that CKC proved to be more beneficial in improving gait performance as compared to OKCE.

Conclusion

The few significantly better functional results for some of the tested parameters in the closed kinematic chain group suggest that this type of exercise is more effective than the open kinematic chain program in rehabilitation of these patients. Thus this study gives a greater clinical confidence in deciding effective protocol for stroke patients.

Key words

stroke, hemiplegia, gait, kinematic chain exercises.

Introduction

Walking is a complex motor task. In order that a person can walk, the loco motor system must be able to accomplish four things (1, 2)1. Each leg in turn must be able to support the body weight without collapsing.2. Balance must be maintained, either statistically or dynamically, during single leg stance.3.The swinging leg must be able to advance to a position where it can take over the supporting role.4. Sufficient power must be provided to make the necessary limb movements and to advance the trunk. In normal walking all of these are achieved without any apparent difficulty and with modest energy consumption.

The human walking step is composed of two different phases .The first phase is the swing phase or single support phase when one foot is on the ground while the other swings. This phase begins with the movement of "lift off" and ends with the collision of swing foot with the ground. Swing phase makes up the majority (80 to 90%) of the duration of the walking step in human walking. The second phase is called the double support phase, both foot are on the ground while the body is moving forward. This phase usually makes up only small part (10 to 20%) of the human walking step (4). However in pathological gait all these above factors can be accomplished only by means of abnormal movements with usually increased energy consumption or by the use of walking aids.

The abnormal movements may be performed for one of the 2 reasons: 1. The movement being forced on them by weakness, spasticity or deformity.2. The movement is a compensation, which the subject is using as the correction for

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some other problem, which therefore needs to be identified (2, 4).

The gait is often destroyed in patients with stroke (5). "Gregor A Doyle" defined stroke as the neurological deficit involving the cerebral circulation that lasts more than 24 hours. If the deficits resolve within 24 hours it is termed as transient ischemic attack (TIA). The signs and symptoms correspond to the involvement of focal areas in the brain (6).

Stroke is the third leading cause of death in the world and United States after Heart disease and cancer (7). Approximately 600,000 strokes of brain attacks occur in the united states each year and of these, approximately 150,000(25%) are fatal .The incidence of stroke is higher in African Americans than Caucasians. In India stroke is the eighth major cause of death. The reported incidence of stroke in India is about 13 to 33 per 100,000 populations per year. This is comparatively lower than in western countries. (6) Average survival rate for stroke victim is 7 years. There were 4.4 million stroke survivors in 1998.The recovery from a stroke depends on its severity.15 to 30% of survivors remains permanently disabled.14% of those who have a first stroke or a transient ischemic stroke (TIA) will have another within one year (8).

Independent walking after stroke has been reported as varying form 26.7% to 75%. Dickstein and colleagues found that at discharge 50.3% of their patients were able to walk independently, with 44.2% requiring the use of a walking aid. It has been established that 53.3% of a group of 368 stroke patients were able to walk independently indoors after 8 weeks. A study of stroke outcome using a motor relearning program for stroke reported 3% of patients reported on improved walking performance and 61.5% of these patients were able to walk independently for a minimum of 3 meters (9).

The quarters of stroke occur in region supplied by middle cerebral artery .MCA is the most common site of occlusion in stroke. (11) The most common characteristics of MCA syndrome are contralateral spastic hemiparesis and sensory loss of face, upper extremity and lower extremity along with contralateral agnosia, hemianopia ,hemiplegia and dysphasia.(12)

A majority of stroke patients are able to walk but their gait is characterized by low velocity, low cadence, short stride length, increase double support phase and asymmetrical single limb support phases. They commonly have a decreased stance time on their affected leg and consequently short time on their affected leg and consequently a short step length with their non-affected leg. This implies an impaired ability to generate an appropriate support movement on their affected leg during single support, thus decreasing the opportunity to step forward with a non-affected leg. (9). Stroke represents a major health crisis for patient and their families. Ignorance about the cause of the illness on the recovery process and misconceptions concerning the rehabilitation program and potential outcomes can negatively influence coping responses and progress in rehabilitation. (12) The ability to walk is the prime factor that determines whether patient will go home or to a nursing home or whether he or she will return to the previous level of productivity after stroke. The goals of rehabilitation should be focused on retaining the ability to walk. (14, 15)

In mild cases, the damage is not extensive, which enables patient to start gait training immediately after stabilizing their medical condition. After finishing the rehabilitation program, some anomalies in gait remain in some patients, whereas in other patients there are no anomalies in gait. In-patient with severe involvement, which refers to the extent of impairment as a consequence of central nervous system lesion size. These patients often bed ridden for a prolonged period of time. Muscle weakness due to inactivity and disturbed muscle control are usually accompanied by balance problems, disturbances in proprioception, contractures in joint; cognitive dysfunction, aphasia and emotional liability. In such patients, the relearning of gait is very difficult and long lasting. These impairments are related to the inability of hemiparetic patients to walk in normal fashion. (5)

Many treatment strategies for stroke rehabilitation have been suggested though the choice of appropriate program remains uncertain. Earlier it's been known that stroke rehabilitation in spastic condition reinforces the abnormal pattern of posture and movement and increase spasticity. Although weakness also contributes to movement dysfunction after stroke, it has been feared that heightened activity level during strength training will further exacerbate the abnormal tone imbalance present in spastic hemiplegia. Moreover findings suggest that spasticity does not increase with training of synergies or strengthening of paretic muscles nor does muscle strengthening cause any decremented effect. Infact, several studies show that strength training can be beneficial to patients in stroke rehabilitation. (16)

Patients and therapists have recognized muscle weakness as the limiting factor in the motor rehabilitation of patients after stroke. (11) Muscle strength of paretic side, however unlike spasticity has been shown to correlate with performance of functional activities, most notably gait. To be more specific it is correlated with gait speed, cadence, independence and distance. (18) Muscle weakness is reflected by the inability of the patients with spastic hemi paresis to generate normal levels of muscle force.

Many studies revealed that a program of muscle strengthening proved beneficial for improving the gait in performance of stroke subjects. Moreover, the independence of gait performance on the function of the affected limb suggests that greater consideration should be directed to the planning of exercises for stroke patients.

A common error in developing an exercise program is failure to assess the proximal and distal segment of entire extremity or kinetic chains during the rehabilitation program. (18) Kinetic chain exercises (open or closed) have been significantly advised during an exercise regime, whether for rehabilitation purposes or for strengthening purposes.

Open Kinetic Chain is an exercise or movement pattern where the distal aspect of the extremity is not fixed to an object and terminates free in space. Typically, open kinetic chain exercises are characterized by a rotatory stress pattern at the joint. Additionally, OKCE movements are typically non-weight bearing exercise. (17,19) OKCE and movement patterns also allow more isolated muscle activation (Palmitier Et Al 1991) because such a limited amount of muscular co.contraction is inherent in these exercise movements. (17,19)

Closed Kinetic Chain is an exercise or movement pattern where the distal aspect of the extremity is fixed to an object that is either stationary or moving. These exercises are typically weight-bearing exercises. This is a multijoint movement.There are several prevalent theories that emphasize that CKCE are functional and Create a co-contraction; particularly in lower extremity because they closely simulate the actual movement patterns encountered in daily activities while OKCE are more of non-functional. (17,19)

Researches have been performed indicating the significant functional improvement following OKC or CKC exercise program respectively. Still there is lack of studies emphasizing on the effect of OKCE and CKCE and gait parameters in sub acute stroke thus initiating further research for establishing an effective rehabilitation program.

The aim of the therapeutic interventions in stroke rehabilitation are directed towards improving the strength and co activation of paretic muscle groups which in turn proves beneficial in improving the gait performance of stroke subjects.

Since studies done on open and closed kinematic chain exercises shows improvement in gait parameters by improving the strength of weak paretic muscles. There is need doing more research in comparing the effect of closed and open kinematic chain to find out which of these elicit better gait improvement, which will help in establishing an effective rehabilitation protocol.

Hypothesis

Alternate Hypothesis

There will be differences in the effect of open and closed kinematic chain exercises in improving gait performance in sub acute stroke patients.

Null Hypothesis

There will be no differences in the effect of closed and open kinematic chain exercises in improving gait performance in sub acute stroke patients.

Review of LIterature

Walking is possible for the majority of patients following stroke, but it rarely return to normal. The gait of people following stroke is characterized by problems with generating, timing and grading of muscle activity, hyper tonicity and mechanical changes in soft tissues. Gait speed, stride length and cadence are lower than normal values.

Common kinematic deviations during the stance phase of gait cycle are :(20)

1. Decreased peak hip extension angle.
2. Decreased lateral pelvic displacements
3. Change knee extension
4. Decreased plantar flexion angles.

Common kinematic deviations during swing phase of gait cycle are (20)

1. Decreased hip flexion
2. Decreased knee extension
3. Decreased dorsiflexion.

During the preswing phase there was a delay in the initiation of flexion of hip followed by delay in flexion of hip and knee as well as dorsiflexion of the ankle progressed only slightly during the swing phase. The duration of the preswing phase was prolonged for patients who had the slowest gait velocity related to normal values stroke gait is characterized by low velocity, low cadence, short stride length, increased double support phases and asymmetrical single limb support phases (21). There were also abnormal movements of upper extremity, the trunk, the pelvis and lower extremity on the unaffected side in an effort to compensate for the decreased velocity on the hemiplegic side (15). Several studies of the characteristic of the movement patterns of gait in hemiparesis have been undertaken; only few have been directly concerned with the disturbed control of muscle activation. Surface electromyograms taken from different leg muscle during walking have suggested a low degree of activity in general both in paretic and non paretic limb. The average EMG activity in four muscle group of paretic leg in different phases of the gait, found more complex changes. Thus in gastrocnemius muscle low average level of activity were found in all the different phases of gait cycle, but in the other muscle examined, average level of activity were decreased in some phases and increased in others. Researches have classified muscle activation problems into the following categories (23):

Variables Affecting Gait

Walking is a complex motor task. Effects on ambulation of variables such as gender, age; standing balance and lower extremity muscle strength have been examined in healthy persons (24,25). After CVA changes occur that may influence a persons capacity to walk. Also change may be the relationship between specific variable and ambulatory status (gait) after stroke (1). Also a research done on 327 persons to establish the relation between age, gender, initial neurological deficit, stroke location, prior stroke, hemisphere of stroke and functional outcome in ischemic stroke have found that positive functional outcome were significantly related to the absence of prior strokes, a younger age, a less severe initial neurological deficit, stroke involving neurological structure and dominant (left hemisphere) lesion (10).Richard W Bohannon found that the gait speed can be expected to be reduced in individuals of greater age and lesser height and lower extremity muscle strength (3).

Bohannon and Andrews confirmed that gait performance is correlated with measures of knee extensor muscle torque (KET) but not spasticity in stroke patients. To be more specific muscle strength of the paretic side, whether indicated by force torque measurements has been found to correlate positively and significantly with gait speed, cadence, appearance, and independence and distance (18). Bohannon found that the body weight, normalized strength of four individuals paretic muscle groups (hip extensors, knee flexors, ankle plantarflexors and dorsiflexors) were correlated with both ambulation speed and cadence in 20 hemiplegic stroke patients. Standing balance has been identified as a predictor of ambulatory capacity (1). Weight bearing ratio was correlated negatively with gait cadence and appearance. Motor control demonstrated a highest correlation with gait measures. As alternating lower limb movements were faster gait performance was better. The normalized total strength of muscle of paretic side correlated significantly and with each gait measurements.

Thus patients who were stronger on their involved side tend to walk better.

Enrique Viosca et al investigated the walking recovery in post stroke subjects using Barthel index and new functional classification scale. Improved walking capacity is detected through out the follow-up process, with a new classification scale but not with barthel index. Patients experienced an improvement in walking recovery throughout the first year after their stroke. The early weight bearing capacity of the affected leg and standing balance were associated with highest walking levels one year after the stroke. (10) Achievement of independent gait is a primary goal for many patients after stroke. It has been found that within 1 week of acute stroke 20% of surviving patients will probably walk normally, but that 20% of patients will be unable to walk without help at 6 months. Wade and associates observed that 81% of long standing stroke patients was independently mobile 6 months after stroke. It has also been reported that stroke survivors who do walk have significantly slow walking speed than normal. (14,26)

Roth Elliot J asserted that velocity is an effective indicator of degree of gait abnormality. he found that velocity is significantly correlated with cadence, mean cycle duration, hemiplegic limb stance phase duration, non hemiplegic limb stance phase duration and percent, non hemiplegic limb swing/stance phase ratio and swing phase symmetry ratio ,velocity is related to most leaving some of the temporal measures of hemiplegic gait.(27) among the time distance parameters, velocity was found to progress first and their after in a descending order, stride length, distance, symmetry, double support time and stance time.(3,7)

Human locomotion is a biomechanical expression of adequate neuromuscular disability. Quantitative evaluation of gait can be done by functional ambulation profile, which provides a practical clinical test of locomotion skill. This profile can be used with severely disabled or mildly afflicted person (28). Titianova studied the gait characteristic and functional ambulation profile (FAP) in patients with chronic unilateral stroke and found the FAP scores of patients reflected well their characteristics spatio- temporal gait variations. However the FAP score seemed a reliable measure of gait abnormality / normality in gait. (29)

Unlike traditional qualitative gait assessment tool ink foot record permits clinically feasible method for assessing temporal – distance parameters (TD) like step length, stride length, cadence and velocity. This provides easy quantification of change and comparison of outcomes across different subjects or treatments. TD values can be measured reliably by this method who have received only a minimum training. inter-rater reliability of this high. The significant relationship of velocity, cadence, step length and SL: LEL to functional ambulation supports the validity of their use as an outcome measure. (30)

Improvement of gait is the most frequently stated goal in stroke patients. Various approaches to stroke rehabilitation, such as facilitation techniques including (1) Proprioceptive Neuromuscular Facilitation techniques (PNF), (2) Brunnstrom's approach (neurophysiologic approach) (3) Bobath approach

(neurodebvelopemental technique), (4) Therapeutic electric stimulation,(5) Electroomyographic biofeedback,(13) (6) Intensive rehabilitation therapy, (7) Constraint induced therapy have been studied to improve the functional recovery of hemiplegia due to brain damage. Specifically there is insufficient evidence that these techniques are superior to conventional exercise therapies. However functional improvements seen with intensive rehabilitation therapies, repetitive training of isolated movements and constraint induced therapy have suggested that therapeutic exercise that includes facilitation techniques may improve motor function of hemiplegic limbs if the facilitation techniques are of adequate intensity and quality and specially if they involve repetition of voluntary movement to be recovered. (31)

Several studies shown that strength training can be beneficial to patients in rehabilitation. (29,39) A short program of task -specific strengthening exercise and training for children with cerebral palsy, run as a group circuit class, resulted in improved strength and functional performance that was maintained overtime. Similarly a short clinically feasible home based training program can lead to lasting changes in the strength of key lower limb muscles that may impact on the daily function of young people with cp. (32)

'Sauvage Jr' found that appropriately designed high intensity program can result in significant although limited improvements for clinical mobility scores, strength, muscular endurance and certain gait parameters (33) .the pattern of motion of lower extremity on the hemiplegic side had a stronger association with the clinical severity of the mu8scle weakness than with the degree of spasticity, balance control or phasic muscle activity. There were abnormal pattern of motion, which altered the velocity, the length of the stride, the cadence and all phases of gait cycle. As velocity improves these abnormal movements decreased. Therefore the goal of therapy should be to improve muscle strength and coordination on the hemiplegic side especially during the preswing phase. (14,15)

'Teixeira-Salmela' evaluated the impact of the combined program of muscle strengthening and physical conditioning on gait performance on subjects with chronic stroke. Gait analysis revealed that the 10 week training resulted in significant increase in gait speed with improvement in walking patterns as determined by increase in selective kinematic and kinetic measures. After training subjects were able to generate higher joint movements and higher level of power produced by major lower extremity muscle groups. (22,34)

Kinematic chain is a series of interrelated joints that constitute a complex motor unit, constructed so that motion at one joint will produce motion at other joints in a predictable manner. Various kinematics describes the appearance of motion, kinetics involves the forces, whether internal (muscle contractions or connective tissue restraints) or external (e.g. gravity, inertia or segmental masses) that affect motion.

In a closed kinematic chain exercises, the terminal or distal segment is opposed by "considerable resistance" .In an open kinematic chain exercise, the distal segment is free to move without any external resistance. (35) In rehabilitation CKC activities we used to restraint joints and muscle proprioceptors to respond to sensory inputs.CKC stimulate proprioceptor, joint stability, increased muscle co activation, allow better utilization of the said(specific adaptations to imposed demands) principle and permit more functional patterns of movement.

In contrast, OKC exercise can isolate a specific muscle groups for intense strengthening and endurance exercises. In addition they can develop strength in very weak muscle that may not function properly in a CKC system because of muscle substitution .OKC may produce great gains in peak force production and are usually limited to one joint in a single plain (uniplanar) and have greater potential for joint shear.

'Koch' states CKCE produces a minimal amount of shear force, while OKCE produces a greater amount of shear. When the knee is extended during kinetic chain exercises there is a strong contraction of the quadriceps .he found that with CKCE there is a co contraction of quadriceps and hamstrings which reduces force placed on knee by stabilizing the knee joint.

OKCE produced more rectus femoris activity while CKCE produced more vastii muscle activity. Tibiofemoral compressive forces was greatest in CKCE near full flexion and in OKCE near full extension. Peak tension in PCL was approximately twice as great as in CKCE and increased in knee flexion. Tension in ACL was present only in OKCE and occurs near full extension. Patellofemoral compressive force was greatest in CKCE near full flexion and in the mid range of knee extending phase in OKCE. (35)

Significant improvement in strength and functionality as a result of both OKCE and CKCE exercise program was maintained over a period. (37) Long-term prognoses of patients who are managed conservatively with an OKC and CKC exercise protocol are relatively good. Maintenance of the quadriceps strength is a notable findings because it's been emphasized the importance of a good quadriceps function as a premise for a good functional result. This relationship between locomotor function and quadriceps strength were already emphasized by 'powers'. (37)

'Norris K.D' et al in his study on 5 cerebral palsy subjects out of which 3 utilized OKC training and 2 CKC. He found significant functional improvements for all OKC and 1 CKC studies. His literature indicated both CKC and OKC strengthening exercise improve function in children and adolescent with spastic cerebral palsy but he was unable to conclude which mode of exercise is more effective. (38)

Judicious thought should be given in choosing the exercises for rehabilitation. Decision should be made related to which exercise best meet the intended goals of the rehabilitation or conditioning program.

Methods

Subjects

Number

30 sub acute stroke patients (15CKCE-15 OKCE).

Source

The research has been conducted in the following hospitals.

1. King George Medical College , Shahmina road, Lucknow .
2. Ram Manohar Lohia hospital Lucknow .
3. National hospital, Rajajipuram Lucknow.
4. Jain Dharmarth Chikitsalaya. Yahiyaganj, Lucknow

Inclusion Criteria

1. Age 40-60 years.
2. Able to ambulate independently without walking aids.
3. Oriented and ability to communicate independently. i.e. mini-mental scale scoring >24.
4. Sub acute stroke patients (3 months post stroke).
5. Full range of motion in hip, knee and ankle.

Exclusion Criteria

1. Any associated medical problem.
2. Any high-risk cardiovascular disorders.
3. Any sensory deficits.
4. Spasticity >1 modified ashworth scale.
5. Visual impairments and upper limb impairment.

Sampling

Sample of convenience of 30 subacute stroke patients has been taken.

Instruments and Tools Used

Measurement Tools

· Functional ambulation profile.
· Ink footprint record method.

Materials Used

· Ink
· Stop watch
· Marking pen
· Marking tape

Procedure

Design of Study

Randomized control trial.

Methodology

Subjects were tested on two measurement scales of functional ambulation profile (FAP) and ink foot-print record method on two occasions during the study i.e. prior to the beginning of the rehabilitation program and 5 weeks after the training for comparing the pre and post condition of the subjects.

In FAP patients were assessed on all the three phases, progressing from static bilateral stance through independent ambulation. In each case, the subject was asked to hold the position as long as he could or until 60 seconds had elapsed. The time was measured with a stopwatch.

Each exercise in both (OKC and CKC) training groups was repeated for 3 sets of 10 repetitions .the patients rested for 1 min after the conclusion of each set. Exercises are given for duration of 5 weeks, 3 times a week for 30-45 minutes in the okc exercise protocol, each exercise was held isometrically for count of 6 seconds with a 3 seconds rest between repetitions. Each exercise in the CKC protocol was performed dynamically with 3 seconds between repetitions. The exercise protocols were as follows:

The exercise program for OKC exercise group was:

- Maximal static quadriceps contractions (quadriceps setting) with the knee in full extension.
- Straight leg raising with the patient in the supine position.
- Leg adduction exercises in the lateral decubitus position.

The exercise program for CKC exercise group was:

- Double or single one-third knee bend.
- Stationary bicycling
- Step up and down exercise.

5 -Weeks Follow-up

28 of the 30 patients attended the 5-week intervention program. Two (one from each treatment group) of these 30 patients left the treatment in between because of another attack of stroke during this period. Therefore, the results of these patients were not used in the statistical analysis of this follow- up study.

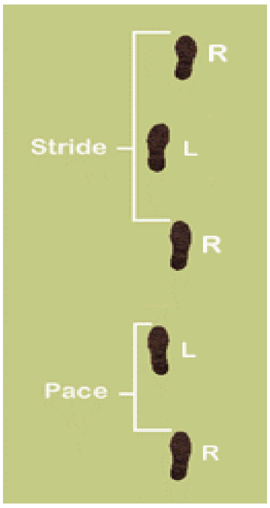


Figure 1: Stride and step length

Figure 2: Stride and step length


Figure3: Static quadriceps contractions

Figure 4: Straight leg raising

Figure 5: Leg adduction exercises

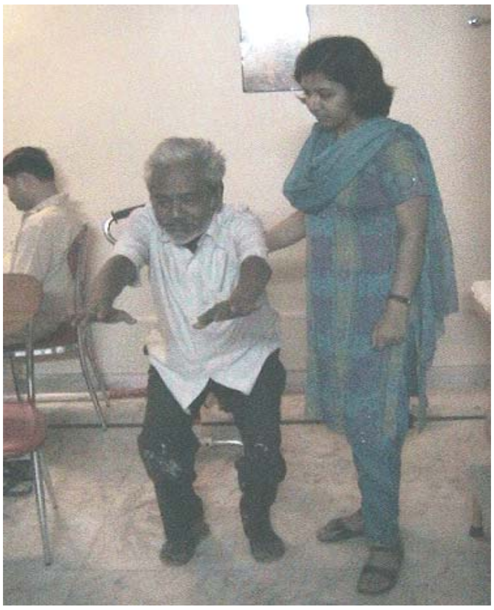


Figure 6: Double one-third knee bend.

Figure 7: Single one-third knee bend

Figure 8: Stationary bicycling

Figure 9: Step up and down exercise.

Data Analysis

Statistics was performed using STATA 15.0 and SPSS software. T test was used to analyse the difference between the performance of the subjects in the two groups A and B before and after the intervention.

TABLE 1: FUNCTIONAL AMBULATION PROFILE OF TWO GROUPS

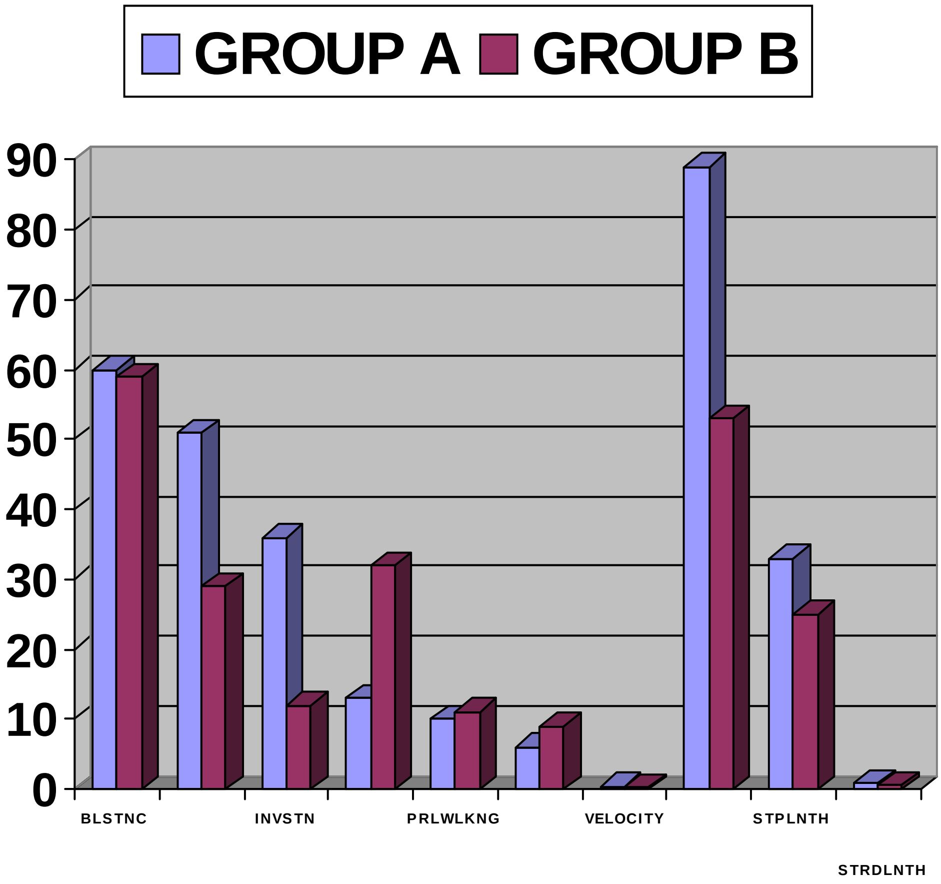
VARIABLES	GROUP A (N= 14)		GROUP B (N=14)	
	MEAN	S.D.	MEAN	S.D.
BLSTNC	60.00	00.00	59.07	3.47
UNINVSTNC	51.92	11.15	29.07	16.42
INVSTNC	36.07	20.52	12.78	11.87
WtTFR	13.50	04.20	32.00	18.01
PRLWLKNG	10.00	10.45	11.14	11.64
INDWLKNG	06.78	07.11	09.00	± 09.40
VELOCITY	0.372	0.084.	0.3050	0.045
CADENCE	89.28	11.53	53.35	19.39
STPLNTH	32.07	06.42	25.14	04.84
STRL by Leg LNTH	00.77	00.13	00.48	00.16

Table: 1. BLSTNC:-BILATERAL STANCE; **UNINVSTNC**: - UNINVOLVED STANCE; **INVSTNC:** INVOLVED LEG STANCE; **Wt TFR: -** WEIGHT TRANSFER; **PRLWLKNG**: - PARALLEL BAR WALKING; **INDWLKNG**: - INDEPENDENT WALKING.

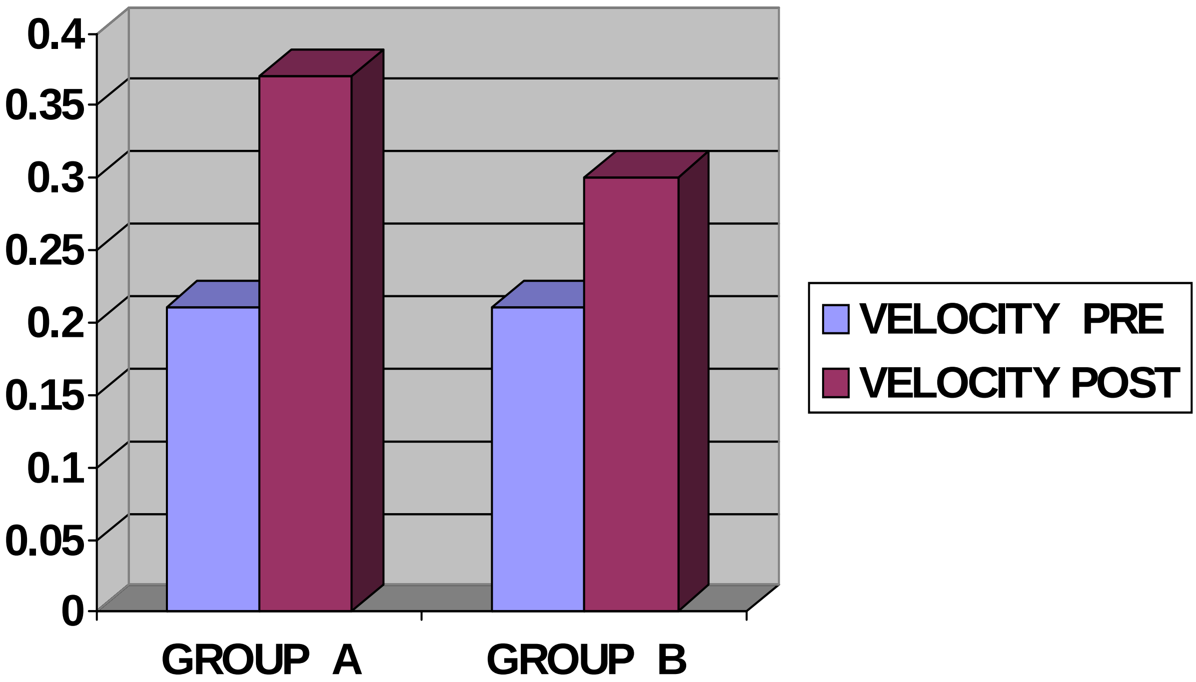
TABLE 2: GAIT PARAMETERS OF TWO GROUPS

VARIABLE	GROUP A		GROUP B	
	PRE INTERVENTION	POST INTERVENTION	PRE INTERVENTION	POST INTERVENTION
VELOCITY (m/sec)	00.21 ± .047	00.37 ± 00.08	00.21 ± 00.03	00.30 ± 00.04
CADEMCE (steps/min)	47.57 ± 09.76	89.28 ± 11.53	40.64 ± 16.79	53.35 ± 19.39
STEP LENGTH (cm)	22.35 ± 03.89	33.07 ± 06.42	17.28 ± 03.98	25.14 ± 04.84
STRIDE LENGTH/ LEG LENGTH RATIO	00.55 ± 0.155	00.77 ± 00.13	00.35 ± 00.08	00.48 ± 00.16

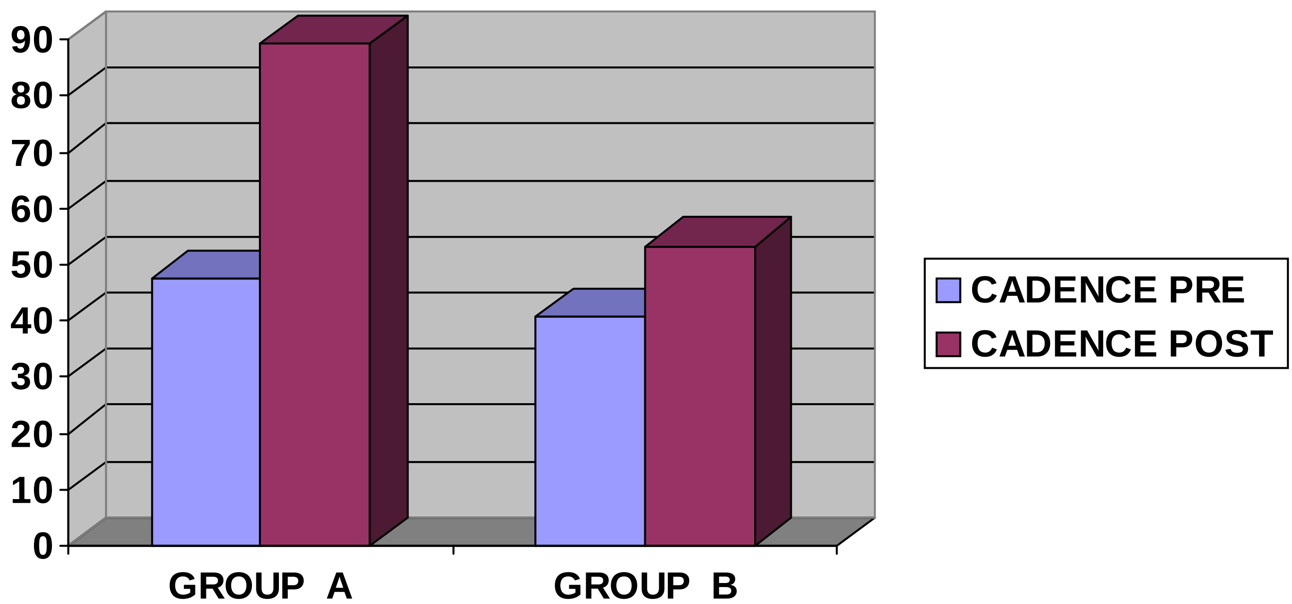
GRAPH 1:FUNCTIONAL AMBULATION PROFILE OF GROUP A & B



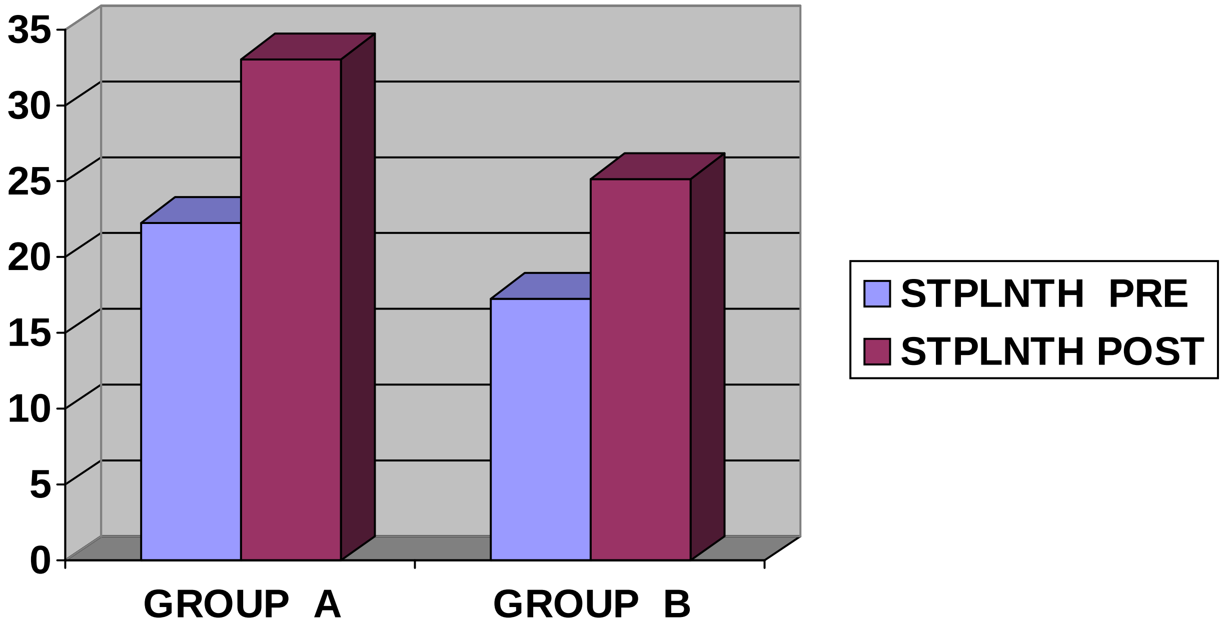
GRAPH 2: VELOCITY OF GROUP A & B



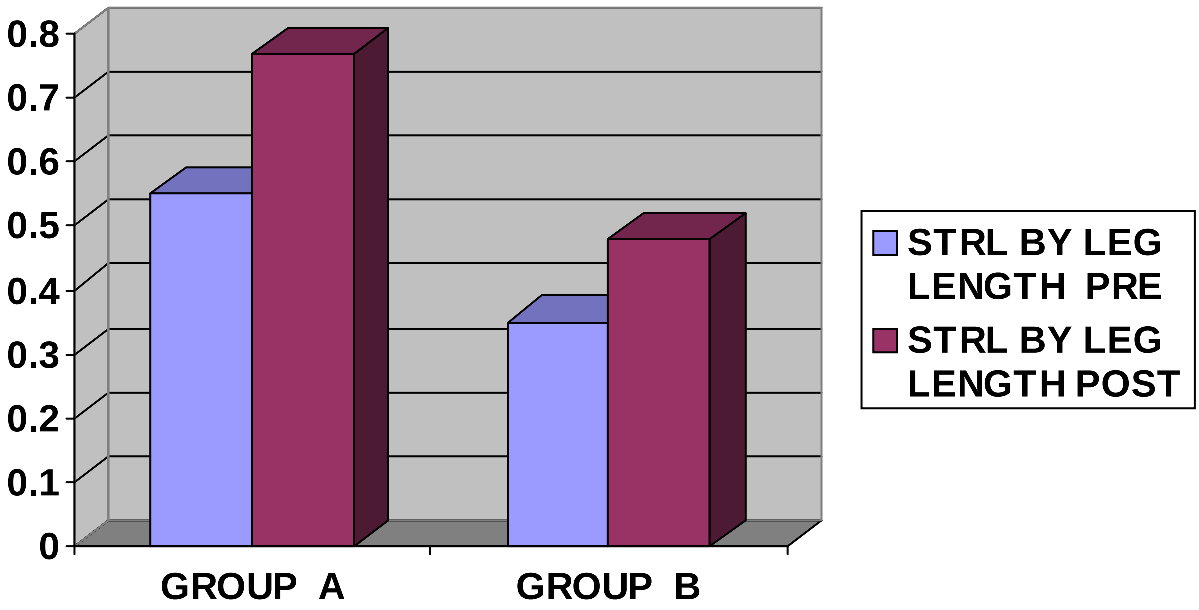
GRAPH 3: CADENCE OF GROUP A & B



GRAPH 4: STEP LENGTH OF GROUP A & B



GRAPH 5: STRIDE LENGTH OF GROUP A &B



Discussion

The results of this study revealed that kinematic chain exercises shows a significant improvement in sub acute stroke patients, though there were favorable and significant differences between the effects of open kinematic chain and closed kinematic chain exercises. Results show that CKC proved to be more beneficial in improving gait performance as compared to OKCE.

OKC exercises can isolate a specific muscle group for intense strengthening and endurance exercise, thus allowing more isolated muscle activation because such a limited amount of muscular co.contractionis inherent in these exercise movements in addition they can develop strength in very weak muscles that may not function properly in CKC systems because of muscle substitution. OKC exercise may produce great gains in peak force production and are usually limited to one joint in a single plane (uniplanar).

OKC are characterized by a rotatory stress pattern at the joint. These exercises are non-weight bearing exercises (19).

CKC activities be used to restrain joints and muscle proprioceptors to respond to sensory input .CKC exercises provides greater joint compressive forces. In CKCE, multiple joints are exercised through weight bearing and muscular contraction; velocity and torque are more controlled, shear forces are reduced, joint congruity is enhanced; proprioceptors are re-educated; postural and dynamic stabilization mechanics are facilitated and exercise can work in spiral or diagonal movement patterns (19).

CKC stimulates proprioceptors, increase joint stability, increases co. activation, allow better utilization of the said(specific adaptations to imposed demand) principle and permit more functional patterns of movement particularly in lower extremity because they closely stimulate the actual movement patterns encountered in daily activities (19).

In cases where stroke is accompanying other degenerative conditions (e.g. O.A) thus restricting weight bearing, it may prevent certain CKC exercises from being used, here OKC exercises are not limited because of their non- weight bearing nature.

Closed chain motion alters the nature of muscle contractions as well as bone motion. During dorsiflexion of ankle joint; in open chain dorsiflexion, the dorsum of

the foot moves up towards the lower leg while in closed chain dorsiflexion of the ankle(for e.g. during gait) occurs when the tibia moves forward while the foot remains stationary on the ground. This motion is not produced by contraction of the dorsiflexor muscles. Rather, the dorsiflexion results from forward movement of the lower leg over the foot. The muscles that produce plantar flexion (the calf group) are active during closed chain dorsiflexion to eccentrically control this motion. Thus the problem of foot drop in stroke patients can be overcomed (40).

Obligatory internal rotation of the lower leg occurs whenever subtalar joint goes into pronation and external rotation occurs with supination.

These rotations are important along with hip and knee motion during gait. Motion of the subtalar joint creates a dynamic change in arch height. During chain pronation arch height decreases as while with supination height relatively increases. Closed chain pronation not only lowers the arch but also lowers the pelvis by creating a functional decrease in leg length. Any change in subtalar joint motion leads to asymmetric motion of the pelvis (40).

CKC exercises like squatting, step-up and down, bicycling concentrates on co. contraction of the quadriceps, hamstrings, hip flexors, soleus and gastrocnemius muscles. Also since this is a multijoint movement, it focuses on the knee, hip and ankle (36,41).

Squat strength requires muscle recruitment for hip and knee joint performance. Several studies have shown that strength training improves balance. However, improved balance scores have been reported after improved hip, knee and ankle strength. Clinically, muscle weakness has been recognized by patients and therapists as a limiting factor in the gait rehabilitation of patients after a stroke. Many studies revealed that a program of muscle strengthening proved beneficial for improving the gait performance of stroke subjects. Significant improvement in strength, balance and functionality as a result of both OKC and CKC program was found.

The appropriately planned rehabilitation program on the basis of the results can allow a patient to achieve better recovery in gait performance.

Future Research

This study has established that OKC and CKC have improvement in gait performance in sub acute patients and comparison been done between the effects of these revealing better improvement in CKCE group.

Future research is needed to identify the effect of more intense OKC and CKC exercises on stroke patients in all the stages of recovery. The effects of OKC and CKC exercises on lower extremity function and trunk balance in stroke patients need to be elucidated.

Conducting related studies in different neurological patients such as paraplegia, CP, head injury and other disorders can carry this study forward.

Relevance in Clinical Practice

The findings of this study revealed that CKC and OKC demonstrated good subjective and overall functional outcomes, thus indicating significant relevance to clinical practice.

CKC and OKC exercises in regular therapeutic program in gait rehabilitation would constitute an advantageous and effective adjunct in improving hemiplegics gait in sub acute stroke patients.

This study establishes that CKC exercises have a better improvement in gait performance in sub acute stroke patients thus, this study give a greater clinical confidence in deciding effective protocol for stroke patients.

Conclusion

Judicious thought should be given in choosing exercise for rehabilitation program. Decision should be made relative to which exercise best meet the intended goals of the rehabilitation or conditioning program.

This study found that statistically significant improvement on the gait performance in sub acute stroke patients by CKC and OKC have occurred. Along with this we can also conclude that CKCE have better improvement as compared to OKCE.

Thus the hypothesis that there will be differences in the effect of OKC and CKC exercises in improving gait performance in sub acute stroke patients holds true.

Limitations of the Study

1) Sample size is small. (30 patients were included).
2) Duration of the study is small (5 weeks).
3) ACA, PCA stroke patients were not included.
4) Chronic stroke patients were not included in the study.

Consequently it is difficult to generalize the results to all / other stroke patients

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