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ARTICLE

The Effects Of Closed And Open Kinetic Chain Exercises On Lower Limb Muscle Strength In Sub Acute And Chronic Stroke Patients.

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ABSTRACT:

Background

Muscle weakness is a common consequence of stroke and can result in a decrease in physical activity. The aim of this study was to examine the effects of the close kinetic chain (CKC) exercise and open kinetic chain (OKC) exercise on muscle strength of the paretic lower limb in subacute and chronic stroke subjects.

Methodology: Thirty patients with subacute and chronic stroke were enrolled. They were randomly allocated to three groups: CKC exercise group (n = 14), OKC exercise group (n = 14) CKC and OKC exercise groups were trained 4 times per week for 4 weeks.

Results: Muscle strength was significantly increased in both CKC exercise and OKC exercise groups P (0.001). However, muscle strength was significantly increased in only the CKC exercise group. P (0.001)

Conclusion: The present study indicates that CKC exercise can improve lower limb muscle strength in sub-acute and chronic stroke subjects, leading to the improved functional performance of stroke survivors.

Introduction:

Stroke is the third leading cause of death globally and the United States after Heart disease and cancer. 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. The 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. Stroke is a leading cause of chronic physical dysfunction owing to muscle weakness, incoordination, loss of dexterity, and so forth (Yang et al., 2006). In particular, muscle weakness is one of the most prominent motor impairments of stroke, which limits the recovery of physical functioning, such as balance, gait performance, and activities of daily life[1].

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Muscle-strengthening of stroke patients is generally divided into low-intensity resistance training, high-intensity training, and progressive resistance training. Progressive resistance training (PRT) refers to progressive increases in resistance to a muscle as training induces a more remarkable ability to produce and sustain force [2]. The critical elements of PRT are to provide sufficient resistance, to increase the amount of resistance progressively as strength increases, and to continue the training program for benefits to accrue. PRT has been used successfully to restore function in older adults with chronic disease and frailty. The early stroke rehabilitation literature has raised concerns that resistance training might adversely affect movement performance by increasing spasticity. However, a recent study has reported that no empirical evidence supports these claims[3]. Moreover, PRT effectively improves muscle strength following a stroke (Flansbjer et al., 2008; Yang et al., 2006). PRT is largely classified into the close kinetic chain (CKC) exercise and open kinetic chain (OKC) exercise (Bakhtiary, & Fatemi, 2008; Fleming, Oksendahl, & Beynnon, 2005; Jan et al., 2009). CKC exercise of the lower extremity is typically performed with feet fixed on a stable object that generates compressive forces in the hip, knee, and ankle joints. CKC exercise has been shown to increase muscle strength and neuromuscular control of the lower extremity in young athletes (Fleming et al., 2005; Jan et al., 2009). The benefits of CKC exercise are becoming accepted and employed in the clinical setting. In contrast, OKC exercise that is performed where the hand or foot is free to move is thought to improve muscle strength rather than improve proprioception during knee flexion and extension (Bakhtiary, & Fatemi, 2008; Irish et al., 2010). Several studies have investigated the effect of muscle strengthening and balance ability on musculoskeletal injury patients (Jan et al., 2009). However, the effects of CKC and OKC exercises in patients with stroke have not been well suggested. To our knowledge, only two randomized controlled studies have rigorously investigated the effect of PRT in stroke patients with residual impairments (Flansbjer et al., 2008; Yang et al., 2006). Moreover, a few studies have reported the effect of PRT in stroke patients in terms of muscle strengthening and balance.[4] Therefore, we investigated whether CKC and OKC exercises have improved physical functioning in patients with subacute and chronic stroke, such as the paretic lower limb's muscle strength.

METHODOLOGY

The study was conducted in MVPS Dr Vasantrao Pawar Medical College and Hospital, Physiotherapy OPD, and Prayas Disability Centre. It was a randomized control trial study conducted on subacute and chronic stroke patients. Twenty-eight patients were included in the study. Both male and female subjects diagnosed as stroke those who had more than stage 4 of motor recovery for leg, aged between 40-60 years, Able to ambulate independently without walking aids, orientation, and ability to communicate independently. i.e. mini-mental scale scoring >24. Patients with Any associated medical problem, high-risk cardiovascular disorders, sensory deficits, Spasticity >1 modified Ashworth scale were excluded from the study. Ethical clearance from Dr Vasantrao Pawar Medical College was taken. After getting informed consent from the patients, all the selected subjects underwent a pre-treatment assessment for voluntary control grading. Then closed kinematic chain (CKC) exercise was performed in a sitting position. Participants were instructed to sit comfortably on the chair and maintain the knee at 90 degrees of flexion with feet supported on the ground. Participants were then instructed to do, sit to stand transitions; if needed, upper extremity support was given. The open kinematic chain (OKC) exercise was performed in a sitting position. Participants were instructed to sit comfortably on the chair and maintain the knee at 90-degree flexion with a free distal extremity. They were asked to extend their paretic leg and slowly flex the knee joint to the starting position. CKC and OKC exercise groups were trained 4 times per week for four weeks. After four weeks, all participants were measured for muscle strength of the paretic lower limb.

STATISTICALANALYSIS

The group (Intragroup) comparisons of the change in the voluntary control grading score PRE & POST were assessed using a paired t-test. The group (Inter group) comparisons of the change in the voluntary control grading score PRE & POST were evaluated using the unpaired t-test. A Confidence Interval of 95% was chosen. Probability values of less than < 0.05 were considered significant.

RESULTS

A total of 28 subjects were included in the study. 14 subjects were assigned to the closed kinematic chain Group & 14 subjects were assigned to the open kinematic chain group. All the subjects finished their intervention period of 4 weeks.

Table no.1: Demographic data of the subjects included in the study

Sr. no.	Demographic value	CKC Group n = 14	OKC Group n = 14	P value	Significance
1	Age	52.87	52.28	0.75	NS
Gender					
2	Male	6 (40%)	8 (60%)	0.9235	NS
	Female	8 (60%)	6(40%)		
3	Duration of stroke	7	6		

Table no 2. Comparison of pre & post-treatment values within CKC and OKC Group.

	CKC Group	OKC Group
Pre treatment	4.46	4.44
Post treatment	5.00	4.80
P value	0.001	0.001
Significance	Significant	Significant

Graph no 1. Comparison of pre & post-treatment values within CKC and OKC Group

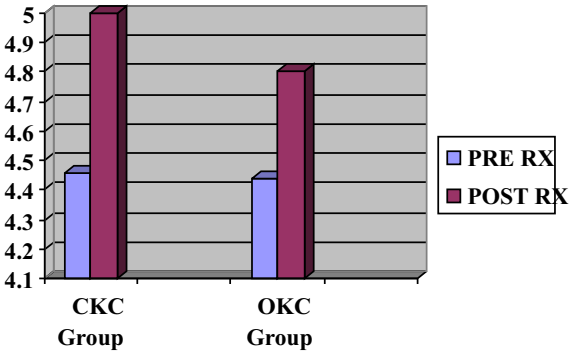
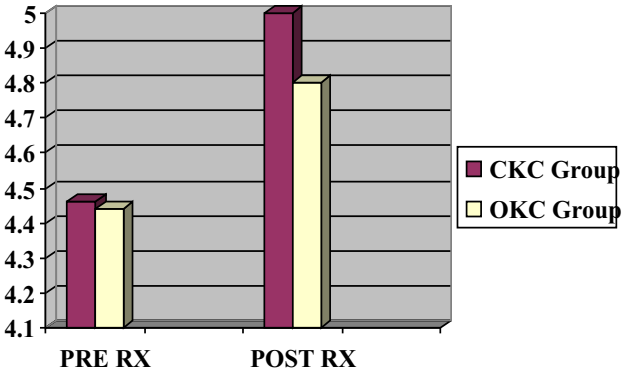


Table no 3. Comparison of pre & post-treatment values between CKC and OKC Group

	CKC Group	OKC Group	P-value	Significance
Pre treatment	4.46	4.44	0.1479	Not Significant
Post treatment	5.00	4.80	0.001	Significant

Graph no 2. Comparison of pre & post-treatment values between CKC and OKC Group



DISCUSSION

The present study was conducted to find The effects of closed and open kinetic chain Exercises on lower limb muscle strength in subacute and chronic stroke patients. Twenty-eight patients who had grade 4 of motor recovery were included in the study. Patients involved in the study went through closed and open kinetic chain Exercises.

The CKC and OKC exercise groups show significant improvement in the muscle strength of the paretic leg.[5] Using PRT, we have demonstrated that relative gains in muscle strength for the paretic lower limb ranged from 31.4–66.7%. Similarly, Weiss et al. (2000), using a lower extremity PRT program, have reported that relative gains in the muscle at the paretic side averaged 68%. These results indicate that the improved rates of CKC and OKC exercises are similar to that of traditional PRT [8]. However, in the present study, the PRT program was divided into the CKC and OKC exercise groups.

It is possible that the CKC exercise may help strengthen the quadriceps and hamstrings simultaneously while also using the hip and ankle joints. This would, therefore, provide feedback from the entire lower extremity (rather than simply form the exercised joint in OKC exercise), and hence the increase in the stimulation of mechanoreceptors around the joint and firing muscle spindles[6]. Indeed, CKC exercise induces a greater calf muscle stretch than in OKC exercise, thus, increasing the afferent information arising from the muscle spindle and Golgi tendon organs of the calf muscles; the CKC procedure requires a more eccentric knee extensor strength to control the movement than the OKC procedure, thus recruiting more motor units, activating more muscle spindles. Additional, crucial afferent information could be added in CKC by Golgi tendon organs, which are activated more in this procedure as a consequence of the increased tension generated by the knee extensors. These results indicate that CKC exercise maybe the proper training method in for stroke patients.[7]

OKC exercises can isolate a specific muscle group for intense strengthening and endurance exercise, thus allowing more isolated muscle activation because of such a limited amount of muscular co-contractions 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 is characterized by a rotatory stress pattern at the joint. These exercises are non-weight-bearing exercises[11]. CKC activities are used to restrain joints and muscle proprioceptors from responding to sensory input. CKC exercises provide 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 a spiral or diagonal movement patterns[8]. 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 the lower extremity because they closely simulate the actual movement patterns encountered in daily activities [9].

Strengthening the paretic lower limb training is one of the most important treatment repertories to enhance functional ability[10]. CKC and OKC exercises are universal intervention methods to strengthen paretic muscles in stroke rehabilitation. Our results provide rehabilitation clinicians with clinical evidence regarding the effectiveness of those two exercises. Simultaneously, the results of the current study should be interpreted with consideration of potential limitations. First, we recruited a homogenous sample of high functioning independently ambulatory subjects with stroke. Therefore, further studies may be needed to clarify this issue.

Conclusion

The present study indicates that CKC exercise can improve lower limb muscle strength in sub-acute and chronic stroke subjects, leading to the improved functional performance of stroke survivors.

Relevance in Clinical Practice

This study establishes that CKC exercises better improve muscle strength in sub-acute and chronic stroke patients. Thus, this study gives greater clinical confidence in deciding effective protocol for stroke patients.

Limitations

1) Sample size is small. (28 patients were included).
2) Duration of the study is small (4 weeks).
3) Acute stroke patients were not included in the study.

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

Future Research

This study has established that OKC and CKC have improved lower limb muscle strength in subacute and chronic stroke patients. A comparison was done between the effects of these, revealing a 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 recovery stages. And future study should EMG as an outcome measure to see the recruitment of the motor unit.

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