Effect of Open and Closed Kinetic Chain Exercises on Wrist Proprioception and Hand Function in Children with Hemiparesis

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ABSTRACT

Background and purpose: *Hemiplegic cerebral palsy is the most common type of cerebral palsy (CP). The function of the impaired side is influenced by abnormal patterns of muscle tone, alternation of proprioception, decreased power, reduced speed of movement, poor grasp and release functions. Hand skills are critical to interaction with the environment; it allows us to act with our world through contact with our own and others' bodies and through contact with objects while proprioception is the process by which the body reacts to change in joint position. Compared with motor impairment in children with hemiplegic cerebral palsy, less attention has been paid to sensory feedback processing deficits. This includes, proprioceptive information regarding wrist position. This study was to investigate the effects of open kinetic chain (OKC) and closed kinetic chain (CKC) exercises on alternation of wrist proprioception and hand function in children with hemiparesis.* ***Subjects:*** *Thirty children with spastic hemiparesis from both sexes ranging in age from five to seven years represented the sample of the study. The degree of spasticity ranged from 1 to 1+ according to the Modified Ashworth Scale. The affected upper limb was free from any structural deformities; however, children demonstrated variable degrees of tightness. They were assigned randomly into two groups of equal number A (control) and B (study).* ***Procedures:*** *Evaluation before and after six months of treatment for each child of the two groups was conducted via using electrogoniometer to evaluate repositioning error through Active Reproduction of Active Positioning test (ARAP). Peabody Developmental Motor Scale (PDMS-2) was used to evaluate hand functions. Group A received a selected exercise program, while group B received OKC and CKC exercises program training in addition to the same exercise program given to group A.* ***Results:*** *The results revealed no significant differences in all variables used in evaluation when comparing the pre-treatment results of the two groups, while significant improvements were observed in all the measuring variables of the two groups when comparing their pre and post-treatment mean values. Significant differences were also observed when comparing the post-treatment results of the two groups in favor of group B.* ***Discussion and Conclusion:*** *Open and closed kinetic chain exercises should be used in conjunction with therapeutic exercise program for the improvement of wrist proprioception and hand function in children with hemiparesis.*

Key words: *Hemiplegic cerebral palsy, kinetic chain exercises, Wrist Proprioception, Hand function.*

INTRODUCTION

Cerebral palsy (CP) is the most common cause of physical disability in childhood and may affect the child on several health dimensions. The motor signs include primary neuromuscular deficits, such as spasticity, muscle weakness and decreased selective motor control, and secondary musculoskeletal problems, such as shortening and contractures. CP is often accompanied by disturbances of sensation, perception, cognition, communication, and behavior[41]. It is a static, non- progressive motor impairment in the developing fetal or infant brain .the resulting impairments affect functional independence and quality of life[22].

Hemiplegic cerebral palsy is the most common type and constitutes a major form among spastic types. It accounts about one third of all cerebral palsied children as a result of unilateral brain lesion[3]. Spastic hemiplegia is characterized by spasticity in the arm and leg on one side of the body and most of them walk independently but there is wide variation in the function of the affected arm and hand[35].

Children with disability affecting hand skills has less opportunity to take in sensory information from the environment and to experience the effect of his or her actions on the world[13]. They suffer from difficulties with fine motor coordination which include poor use of the involved hand for hand skills such as reaching, grasp, release, in hand manipulation and bilateral hand use[11]. In addition, they have difficulty in moving the hand quickly, and are frequently unable to grasp small items with a pincer grasp. Weakness of the wrist and forearm is often associated with limitation of range of motion of wrist extension, supination and elbow extension may be restricted[13]. Limitations in ROM may occur as a result of abnormal tone, poor joint structure and muscle weakness. Any of these problems that decrease range of motion are likely to affect the child's ability to use his hand[48]. Muscle system acting on the hand and upper extremity not only makes it possible for the hand to fully flex and extend fingers at joints, but these balanced systems also provide selective positioning for the fingers and thumb in a wide variety of postures and degrees of contact with objects[14].

Children with hemiplegia, frequently demonstrate somatosensory problems as joint-position sense and kinesthesia deficits, in their impaired limbs[47]. They tend to rely disproportionately on visual input to maintain posture and to position their limbs, which may reflect deficits in proprioception[31]. Individuals with hemiplegic CP have deficits in the proprioception also in the ability to determine whether index finger movement had occurred and in which direction[17].

In the upper extremity, simple open kinetic chain (OKC) exercises has been used for improving proprioception[2]. Closed kinetic chain (CKC) exercises have been concluded to be the most valuable for proprioceptive training for the upper extremities[28]. In the OKC, the distal segment constituting the joint in use, is not in contact with a fixed and/or immovable surface, and bears no weight from the body. The movement pattern in the OKC exercises is characterized by rotary stress in the joint; joint movements occur in isolation; muscle recruitment and movements are isolated; joint axis is stable during movement patterns; the proximal segment that forms the joint is stable, and the distal segment is mobile; motion occurs distal to the instantaneous axis of rotation; movement pattern is often non-functional; movement causes shear forces in the joint[41].

The CKC exercises are characterized by, the distal end of the extremity is fixed to something. The movement pattern is characterized by linear stress in the joint. Multiple joint movements occur simultaneously with multiple muscles are recruited. Movement pattern are functional causing compressive forces in a joint. There is co-contraction of the muscles surrounding the joint with movement often occurs in multiple planes simultaneously; muscles and joints are physiologically loaded provides normal proprioceptive or kinesthetic feedback. Velocity is variable through a movement pattern. Movement causes compression of the joint surfaces, thereby increasing joint stability, and this exercises are more functional[12].

It would be of interest to know whether open and closed kinetic chain exercises might help to improve wrist proprioception and hand function in children with hemiparesis.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Thirty children with hemiparesis (13 right sided and 17 left sided), their age ranged from 5to7years (X`= 5.83 ± 0.6 years) represented the sample of this study. They were selected from both sexes (twelve girls and eighteen boys) from outpatient clinic, Faculty of Physical Therapy, Cairo University. The degree of spasticity ranged from 1 to 1+ according to the Modified Ashworth Scale[5]. They had sufficient cognition and were able to understand commands or instructions which were included in both testing and training sessions. They had partial volitional control over the antispastic muscle groups. Exclusion criteria were the presence of any medical conditions that would severely limit a child's

participation in the study as vision or hearing loss or structural deformities of the affected upper limb however, children demonstrated variable degrees of tightness. Children were randomly assigned into two groups of equal number (A and B), by asking each child to pick up an index card out of a box which contains 30 cards (15 card for each group) to determine which group he/she would be in.

Group A (control) received a selected therapeutic exercises program for children with hemiparesis, while group B (study) received OKC and CKC exercises with an emphasis on wrist proprioception and hand function in addition to the same exercise program given to group A. Instructions about testing purpose and methods were provided for each child before each testing session with enough training program for all measurement procedures to make every child familiar with the test. Evaluation procedures took place twice; pre and post study period.

Evaluation was conducted for each child of two groups by determination the reposition error through Active Reproduction of Active Positioning (ARAP) Test and using Peabody Developmental Motor Scale (PDMS-2) to evaluate hand functions.

Instrumentation

For evaluation

I- Materials used for wrist proprioception test (Active Reproduction of Active Positioning Test):

Patients had impaired proprioception confirmed by reposition error at 15 and 30 degree wrist extension. Electrogoniometer measurement was used to determine both the degree of the wrist joint extension and reposition error.

2-Peabody Developmental Motor Scales – Version2:

Evaluation of the reaching abilities of hemiplegic children was carried out for each child in two groups individually before and after six months of treatment through application of PDMS-2.

3- Stop watch.

4- Wooden Box: composed of five walls with the wall facing the patient has two holes at its buttons in order to allow the patient to put his hands through, while the wall on the other side is open to allow the examiner to conduct the test.

For treatment

Physical therapy tools of different shapes in the form of: Mat, wedges, rolls, medical balls, parallel bars, tilting board and large mirror were used in conducting the exercise program. While tools used for fine motor skills are table, cubes, container, paper, marker, book, foam board and three shapes.

Procedures

For evaluation

Before signing a written consent form by the parents, all hemiparetic children and their parents had been informed of all study procedures, and demonstration was conducted before testing to make sure that all children understood the steps of test. Evaluation for each child in the two groups was conducted before and after six months of treatment.

1-Active Reproduction of Active Positioning Test:

Before the testing procedure, electrogoniometer measurement of the wrist joint was performed by the same examiner to exclude limitations in range of motion of wrist joint.

ARAP test was used in this study for testing the presence of proprioceptive deficits in extension, the tested children were in sitting position with back support in front of a table. The forearm of affected upper limb was introduced in pronation in the testing box, so the patient cannot see his hand. Velcro straps were fastened around the forearm proximal to the wrist joint for fixation with wrist free from the box. The electrogeniometer was fastened on the ulnar border of the hand on the tested limb just distal to the wrist joint.

The examiner asked the child to move the wrist joint of the tested limb in 15 and 30 degrees of wrist extension by the guide of the electrogoniometer as instructed by the examiner[26] and holds it for 10 sec, and then the examiner instructed him to return the wrist to the starting position. The child was asked to actively reposition his wrist to the target angle. This procedure was repeated three times. Thirty seconds rest period was taken after each trial. The absolute angular errors was calculated as the difference between each trial

and the target angle, then mean angular error was calculated[45].

2- Peabody Developmental Motor Scales – Version2:

Evaluation of the reaching abilities of hemiplegic children was carried out for each child in both groups individually before and after six months of treatment through application of PDMS-2:

-The child was seated in a comfortable position and received clear explanation about the procedures of the test.

-The examiner was seated side by side to the child or opposing him.

-Materials needed to be administered: Only single item should be on the table and other materials should be kept away from the child's view[15].

Scoring Criteria:

The PDMS-2 is based on scoring each item as 2, 1, and 0. The examiner must decide how to score the item based on his / her judgment of the child's performance and specific criteria for each item. The general criteria for scoring items are as follows:

Score	Description of performance
2	The child performs the item according to the criteria specific for mastery.
1	The child performance shows a clear resemblance to the item mastery criteria but doesn't fully meet the criteria.
0	The child cannot or will attempt the item, or the attempt doesn't show that skill is emerging.

-Entry points: The examiner should use clinical judgment to determine the most appropriate entry point; i.e, that is testing should begin with items on which the child can be successful.

-Basal level: The basal was established when the child receives a score of two on three successive items in a row.

-Ceiling level: Once basal was established, the examiner administered progressively more difficult items until a ceiling was established when the child scores zero on each of three items in a row; then the testing was discontinued.

-Record of Scores: After administration of all tests, raw and standard scores were calculated.

-Raw Scores: Raw scores were the total points accumulated by a child on each subtest (child received a 2, 1, or 0 for each item). They were recorded first before the other scores.

-Standard Scores: Standard scores provide the clearest picture of an examinee's subtest performance.

For treatment

A selected therapeutic exercises program was conducted for each child of the two groups.

Treatment protocol:

Children attended one hour, three times/week for six months training program which included supervised exercise sessions[30].

For the control group:

-Neurodevelopmental technique: It was directed toward inhibiting abnormal muscle tone and abnormal postural reflexes and facilitating more normal patterns of postural control to use these adaptable motor patterns as a basis for the development of skilled functional abilities.

-Facilitation of righting, protective and equilibrium reactions: These exercises were carried through tilting from different positions as (forward, backward, and sideways) in order to improve postural mechanisms via variety of exercises applied on medical ball and tilting board.

-Gait training activities: These exercises were conducted from different positions (sideway, forward and backward) walking between the parallel bars in front of a large mirror. Training of walking in open environment by placing obstacles across walking tract as rolls of different diameters and wedges of different heights. Climbing stairs up and down.

-Selected exercises included:

-Strengthening exercises: These exercises were conducted for antagonistic group of spastic muscles.

-Stretching exercises: These exercises were conducted for shoulder internal rotators, elbow flexors, forearm pronators, wrist flexors, hip flexors and adductors, knee flexors and ankle plantar flexors. The exercises were done according to the child's tolerance with thirty seconds stretching and another thirty seconds rest.

-Facilitation of fine motor skills:

It included exercises to facilitate hand function including basic reaching, grasping, carrying, release and the more complex skills of in-hand manipulation and bilateral hand use. These exercises were demonstrated in front of the child before asking him/her to perform them and the child was in sitting position on adjustable chair and a table with adjustable height is used, with the back erect and the therapist sitting in front of the child. These exercises were in form of the following:

Grasping a cube: The cubes were placed within reach of the child and he/she was asked to hold it.

1- Transferring cube: Each child was asked to pick up a cube and transfer it to the therapist's hand.
2- Releasing cube: The cubes were placed in the child's hand and he/she was asked to release or drop it in a container in front of him.
3- Placing cubes: A number of cubes and a cup were placed on the table and each child was asked to put the cubes into the cup.
4- Building with cubes: Many cubes were put in front of each child and he/she was asked to build different shapes as tower, train, steps, pyramid, wall and bridge.
5- Manipulating paper: A paper was placed in front of the child and he/she was asked to crumple it with his/her hand.
6- Turning pages: A book with thick cover and thick pages was placed on a table and each child was asked to open the book and turn pages.
7- Inserting shapes: A foam board and three shapes were placed on the table and each child was allowed to put shapes in its correct holes in the board.
8- Writing activities: A paper and a marker were placed in front of the child and he/she was asked to draw vertical line, horizontal line and square.
9- Touching fingers: Each child was asked to touch each finger in succession to the thumb, beginning with the index finger.

-Proprioceptive training:

It was performed via approximation and weight bearing exercises as follows:

-Approximation: It was done for all joints of the affected upper and lower extremities through slow rhythmic and regular manner. It was applied at different joint angles.

-Weight bearing exercise: It was done from quadriped position on mat and sitting with support on the affected hand.

For the study group:

All the exercises given for the control group in addition to the open kinetic chain and closed kinetic chain exercises according to Hatches[20].

Open Kinetic Chain Exercises:

First exercise: Joint Position Sense

The child stood sideways to a wall. The researcher drew a random angle on the wall. The child put the ulnar side of his hand next to the bottom ray of the angle, making no contact with the wall. With eyes open, the patient moved his wrist to the second ray of the angle, and held that position for three seconds. The child repeated this 10 times. On the eleventh repetition, he closed his eyes once he aligned his hand with the bottom ray. The child attempted to reproduce the angle with his eyes closed.

Second exercise: the Clock Drill

The child stood facing the wall at a forearm's length. The child pointed at a marker in the middle of the clock with his finger. Using only his wrist, the patient pointed to numbers on the clock as the researcher instructed them over a period of a minute. The time was increased by 10 seconds each week as a progression.

Third exercise: the Wand Balance

The child was instructed to maintain the balance of the wand on his hand for one minute. Child had not been allowed to look at his hand or the wand while balancing. The time was increased 10 seconds each week for progression.

Fourth exercise: Alphabet Trace with Wand

The child stood and held a wand with the wrist in a neutral but ulnarly deviated position.

Using only the wrist and the point of the wand as a guide, the child traced the alphabet in the air. Each week, five more letters of the alphabet were added for progression.

Fifth exercise: Ball Instruction

The child assumed sitting position with the shoulder at 0° and the elbow at 90°. The child held a ball and was allowed to place his wrist in any starting position. The researcher instructed the child to move his wrist in a specific direction so the ball was clearly seen. This was continued for 30 seconds.

Closed Kinetic Chain Exercises:

First exercise: Paddle Ball on the Wall

The child was in standing position with the shoulder at zero degrees and the elbow flexed to 90°. The child held a paddle in his hand with the wrist in neutral position. The paddle was placed on one side of a ball, such that the ball became trapped between the paddle and the wall. Using only the wrist, the child moved the paddle on the ball in up and down, and left and right motions for 30 seconds.

Second exercise: the Wrist Push-up

The child stood about feet from the wall. The shoulders were kept at 0° and the elbow was in a 90° position. The child leaned forward keeping the body straight, with hands flat against the wall. Using only the wrists, the child pushed himself away from the wall and then returned to the starting position. This was performed 10 times, and each week two more push-ups were added for progression.

Third exercise: the Wobble Board Balance

The child kneeled on the floor with body positioned over a wobble board. The elbow was kept straight and the shoulder is flexed about 90°. The child's upper body weight was positioned over the upper extremity. The subjects rocked their wrist in flexion, extension, and radial and ulnar deviation for 30 seconds while maintaining their balance.

Fourth exercise: the Ball Roll

The child assumed the same total body position as in the wobble board balance exercise. The child put the palm of his hand on a ball and applied his upper body weight to his upper extremity on the ball. The child balanced the ball while rolling it in all planes of available motion with his wrist for 30 seconds.

Fifth exercise: the Towel Slide

The child assumed sitting position. A towel was placed on a table in front him. The child sat so only the wrist and hand were on the table, with the fingers only on the towel. Using his wrist, the child slide the towel in increments to the right, and then back to the left. Fifteen increments were performed in each direction. The number of increments was increased by five per week for progression.

Most exercises for the upper extremity use lower repetitions and sets, as well as shorter training periods. This is because the upper extremity musculature is much smaller and adaptations occur much quicker[32,38].

RESULTS

The raw data were analyzed using the SPSS program to determine the mean± standard deviation for each measuring variables of the two groups before and after six months of treatment. Tests included in this study were independent t-test and paired t-test.

The obtained results in this study revealed no significant differences when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in all the measuring variables of the two groups when comparing their pre and post-treatment mean values. After treatment, significant difference was observed when comparing the post-treatment results of the two groups in favor of the study group.

I- Angular error of wrist extension

As revealed from table (1) and figure (1), significant reduction was observed in the mean values of angular error of 15° and 30° wrist extension for the control group at the end of treatment as compared with the corresponding mean values before treatment.

Table (1): Pre and post-treatment mean values of angular error of 15° and 30° wrist extension for the control group.

	15 ° wrist extension		30° wrist extension	
	Pre	Post	Pre	Post
X	9.5	6.8	13.5	10.6
±SD	0.915	1.207	2.166	2.472
t-Test	8.0		5.735	
P-value	0<0.05		0<0.05	
Sig.	Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance

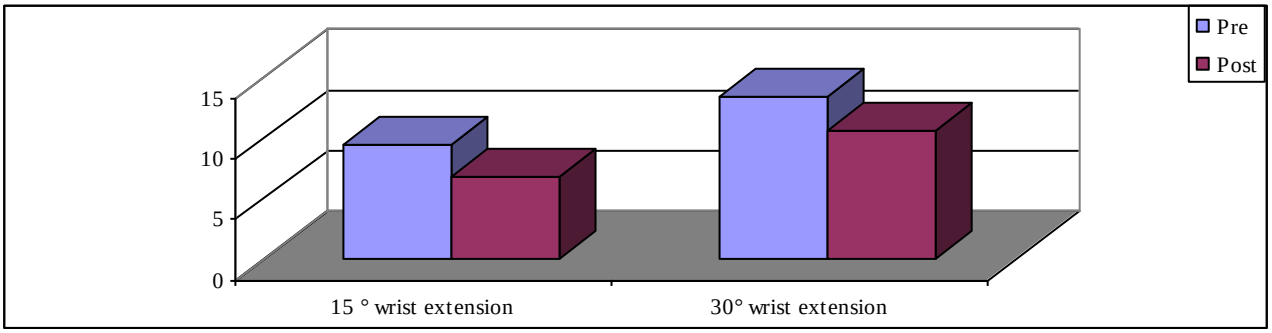

Fig. (1): Demonstrating the pre and post-treatment mean values of angular error15° and 30° for the control group.

Also, table (2) and figure (2), showed a significant reduction in the mean values of angular error for the study group at the end of treatment as compared with the corresponding mean values before treatment.

Table (2): Pre and post-treatment mean values of the angular error of 15° and 30° wrist extension for the study group.

	15 ° wrist extension		30 ° wrist extension	
	Pre	Post	Pre	Post
X	9.4	5.7	13.6	8.9
±SD	0.828	1.222	1.992	1.624
t-Test	9.203		9.628	
P-value	0<0.05		0<0.05	
Sig.	Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance.

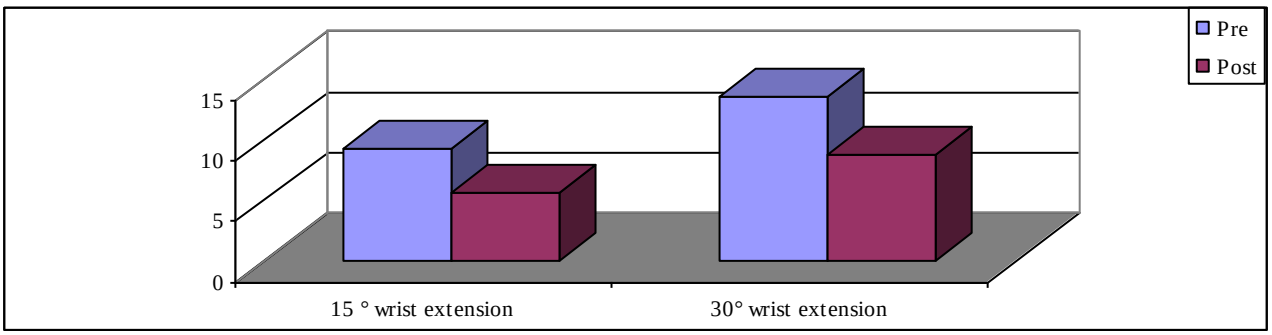

Fig. (2): Demonstrating the pre and post-treatment mean values of angular error 15° and 30° for the study group.

As shown in table (3) and demonstrated in figure (3), significant improvement was also observed when comparing the post-treatment mean values of angular error of the two groups in favor of the study group ($P < 0.05$).

Table (3): Post-treatment mean values of angular error of 15° and 30° wrist extension for the two groups.

	15 ° wrist extension		30° wrist extension	
	Control group	Study group	Control group	Study group
X	6.8	5.7	10.6	8.9
±SD	1.207	1.222	2.472	1.624
t-Test	2. 404		2.182	
P-value	0<0.05		0<0.05	
Sig.	Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance

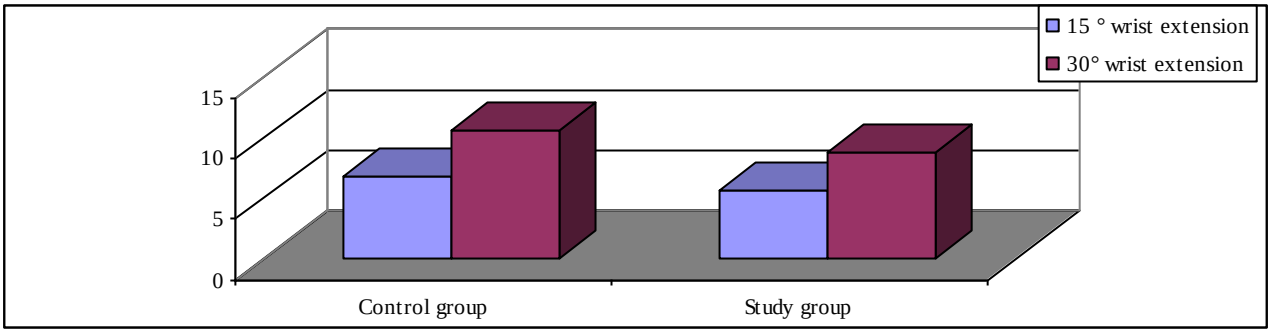

Fig. (3): Demonstrating the post-treatment mean values of angular error 15° and 30° for the two groups.

II- Standard score of pdms-2

As shown in table (4) and demonstrated in figure (4) pre and post-treatment mean values of standard score of PDMS-2 for the control group were4.0± 0.845 and 4.8± 0.833 respectively (P <0.05), which was statistically significant. Significant improvement was observed when comparing pre and post-treatment mean values of PDMS-2 for the study group which were 4.1± 0.789 and 5.7±1.032 respectively (P <0.05). Also significant improvement was also observed when comparing the post-treatment mean values of standard score of PDMS-2 of the two groups in favor of the study group (P < 0.05).

Table (4): Pre and post-treatment mean values of standard score of PDMS-2 for the control and the study group.

PDMS-2	control group		study group	
	Pre	Post	Pre	Post
X	4.0	4.8	4.1	5.7
±SD	0.845	0.833	0.789	1.032
t-Test	5.493		9.539	
P-value	0<0.05		0<0.05	
Sig.	Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance.

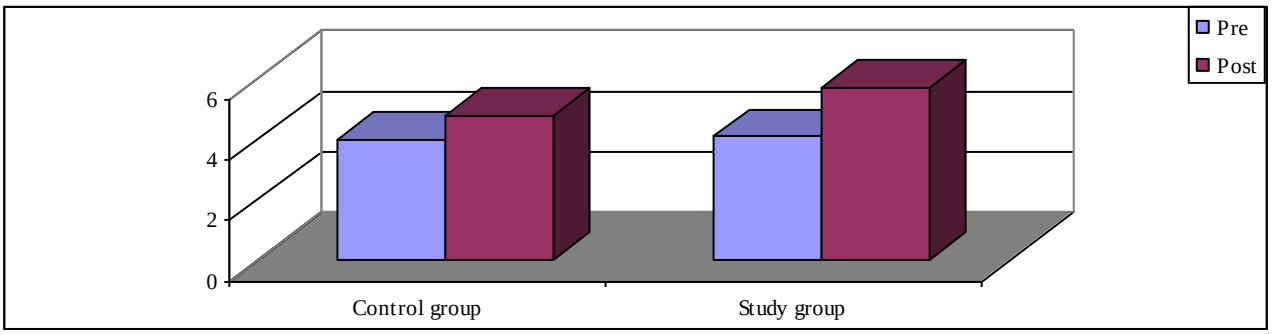

Fig. (4): Illustrating the pre and post-treatment mean values of standard score of PDMS-2 for the control and the study group.

DISCUSSION

This study was conducted to determine the effect of integrating open and closed kinetic chain exercises with therapeutic exercise program on the improvement of proprioceptive senses during functional activities and hand function in children with hemiparesis.

Spastic hemiparetic cerebral palsied children may exhibit abnormal synergies of movement including deficits that interfere with various motor functions such as gross and fine motor skills. These neurological deficits include spasticity, incoordination, and defective motor control that interfere with their motor function. Such children may show a delay in the acquisition of various motor functions such as gross and fine motor skills[18]. Hemiplegic children have difficulty in isolating specific muscles, or they may not be able to find a needed muscle[11].

The data collected from the children of this study before starting treatment revealed that hemiplegic cerebral palsied children suffer from problems of hand functions. This finding comes in agreement with Levin[29] who stated that hemiparetic child suffers from disruption of coordination of shoulder, elbow and wrist range of motion during reaching and grasping which results in functional deficits and interferes with the acquisition of all components of prehension. This also confirmed by Forssberg et al.,[16] who said that movements of the hands and fingers are precise and they agree that this movement develops during early childhood and may be dysfunctional if there is damage of the central nervous system.

Concerning the pre-treatment findings of the present study, they were matched with those reported by Brown et al.,[6] who speculated that the hemiplegic cerebral palsied children with different degrees of spasticity suffer from disturbed tactile discrimination, proprioceptive deficits and variable degrees of hand dysfunction. Moreover, it agrees with Horak and Macpherson[21], who confirmed that those sensory problems can disrupt development of highly skillful tasks in environmental demands.

Choosing hand function to be evaluated confirms the findings of Cook and Woollacott[10], who studied and examined the grasp behavior of disabled children including those with hemiplegia. They revealed that hemiplegic child had very clumsy grasp. Reaching is the primary component of hand function and grasping is the main function of the hand. If the child has any difficulties in hand function either neurological or mechanical or both, he/she will become delayed in achieving the normal sequence of fine motor development. In hemiparetic cerebral palsy, flexor hypertonia, abnormal sensory awareness, delay motor learning, lack of control at shoulders, elbows and wrists, muscle weakness and joints problems, may hinder development of fine motor skills due to abolishing of hand function.

Choosing the age of the children of the present study to be ranging from five to seven years comes in agreement with Myres[34] and Schneck[40] who revealed that, by the age of six years; the grasp patterns become fully matured. Case-Smith[9] confirmed that by the age ranging between five and seven years, the child can assume hand grip with regular force either to grasp or to lift the object without letting it slipping through the fingers. The pretreatment results of wrist extension were consistent with those reported by Duff and Woollacott[11] who reported that, with mild spasticity, the range of wrist joint angle decreases. Gradual decrease in strength of wrist extensor could be attributed to the effect of weakness of the wrist extensor.

The main objective of this study is to reveal the differences in wrist proprioception and hand function control under condition of the OCK and CKC program between two hemiparetic cerebral palsied groups. A total of 30 children participated voluntarily, divided into control group and study group. The OCK and CKC effect on wrist proprioception was compared to the selected physical therapy program which was applied to the control group. This physical therapy program included Bobath technique, facilitation of fine motor skills, proprioceptive training, facilitation of postural mechanisms, gait training, stretching and strengthening exercises.

All children in both groups were assessed before and after the treatment program by using Active Reproduction of Active Positioning test of wrist extension and Peabody Developmental Motor Scale. The measuring variables were the error of repositioning of the wrist joint and hand function. In physical therapy, as in all medical care, a need exists for instrumentation, procedures and assessment tools to document objectively the patient response to treatment. Peabody developmental motor scale was chosen to be used in evaluation of reaching skills; this comes in agreement with Richardson[37], who established that, standardized tests have permitted occupational therapists and other professionals to develop a more scientific approach to assessment. Also, the uses of tests that give statistically valid numeric scores give more credibility to the assessment process this also come in agreement with Van Hartingasveldt et al.,[43] who confirms the accuracy and reliability PDMS2.

The pre-treatment results of the two groups revealed non- significant difference, indicating homogeneity of the sample in the two groups.

Statistical analysis of post-treatment results revealed significant improvement in all the measured variables of two groups A and B when comparing their pre and post treatment mean values.

The significant improvement obtained in the post-treatment mean values of the measuring variables of the control group may be attributed to the effect of treatment activities and a specially selected exercise program for children with hemiparetic cerebral palsied. This agree with Kern et al.,[24] who established that traditional methods of treatment for children with cerebral palsied are focused on attainment of sequential developmental milestones and facilitation of normal movement patterns for the training of functional daily activities.

The specially designed exercise program were to facilitate hand function through many tasks involving reach, grasp, release and other manipulative skills that agree with Bulter, 1998[7] who confirmed that the aim of physical therapy should promote movement control and functional abilities through effective means.

The significant improvement of hand function abilities and movement for control group comes in agreement with An et al.,[1] who stated that, sufficient strength is necessary to initiate all types of grasp patterns and to maintain these patterns during carrying. Children with poor strength may be unable to initiate the finger extension or the thumb opposition pattern necessary before grasp. Also the obtained result after six months of treatment confirm the findings of Levitt 2004[30], who reported that developed positions (reflex inhibiting patterns) is to inhibit hypertonicity and so, facilitate controlled movement.

These results also come in agreement with Cook and Woollacot, 2001.,[10] who stated that the upper extremity control is intertwined with both fine and gross motor skills. Thus, recovery of the upper extremity function is an important aspect of retraining the patient of most areas of rehabilitation including both occupational and physical therapy. These findings are supported by Folio and Fewell, 2000[15], who confirmed that wrist proprioception and hand function in children with hemiparesis improved as the child gains stability around distal and proximal parts. This result also is consistent with Verschueren (1998)[44], who recommended that dynamic control of the wrist joint improves with practice. Thus, proprioceptive activity affects the cortical representation of movement.

Moreover, it comes in agreement with Kluzik et al., 1990[25] who stated that children with spastic cerebral palsy may exhibit a change in quality of movement. These qualitative changes may include improvements in biomechanical alignment during voluntary movement and postural maintenance, improved gradation of movement with increased eccentric muscular control, and improved stability at proximal body parts to allow distal body parts to move with greater control.

Furthermore, it comes in agreement with Schmidt et al., 1989[39], who described the motor skill learning as a set of processes associated with practice and experience,

leading to permanent changes in the capacity for responding and producing skilled action.

The results of the control group at the end of treatment period showed statistical significant improvement in measured variables. The improvement in the ARAP test and PDMS2 can be attributed to the development of upper limb skills that occurred because of proximal and distal control mechanisms.These results also agree with Volman et al., 2002[46], who suggested that providing a functional context to perform a task, may enhance the quality of components of hand function of the affected arm in hemiparetic cerebral palsied children.

The data collected from the children in group B, after successive six months of treatment, receiving the same selected therapeutics program given to group A with a program of OCK and CKC exercises, revealed significant improvement in all measuring variables (ARAP test of wrist extension 15° and 30° and the PDMS2). The comparison between group revealed also significant difference in advance to group B, this difference may be attributed to the effect of the OCK and CKC exercises.

Improvement fulfilled in the study groups might be attributed to the effect of exercises therapy program on muscular control and maintain accurate movement. This agrees with the findings of Carvalho and Almeida[8], who suggested that proprioceptive information is essential for the motor control system to select the appropriate motor strategy of reciprocal activation among the agonist and antagonist to efficiently exhibit normal synergies of movement.

In this study we added the closed kinetic chain exercises to the open kinetic chain exercises despite what is found by Hatches (2005)[20] that the wrist proprioception was improved only by open kinetic chain exercises but with closed kinetic chain exercises will add additional benefits to the exercise program such as allowing the mechanoreceptors within the joints to be more aware and responsive to static and dynamic stability at the joint.

The significant improvement detected in the selected variables in the results of study group may be attributed to the, CKC activities facilitate the integration of proprioceptive feedback coming from pacinian corpuscles, Ruffini endings, and Golgi tendon organ, Golgi ligament endings through the functional use of multijoint and multiplaner movements. And, as the co-contraction or coactivation of agonist and antagonist muscles must occurs during normal movements to provide joint stabilization. Co-contraction which occurs during CKC exercise decreases the shear forces acting on the joint, thus protecting the healed soft tissue structures that might be damaged by open chain exercises[36].

The significant improvement in study group was supported by Blackburn (2000)[4], who conducted a study on closed kinetic chain training protocols for aiding semi-dynamic balance for the upper extremity. He added that closed kinetic chain activities cause adaptations in the central nervous system that alter motor control patterns and allow the development of new patterns based on the stress and strain of the activities. Thus, closed kinetic chain activities have a significant effect on joint stability.

The post treatment results obtained from study group clearly demonstrated the evidence of using OCK and CKC chain exercises. This can be explained by the work of Kuyper[27], who stated that there is a strong relationship between proximal and distal motor function as proximal motor control is necessary for accurate placement of hand during its execution of skill.

In addition, the post-treatment results of the study group reinforced the effectiveness of exercises training on improving wrist proprioception and hand function by adopting suitable program of open and closed kinetic chain exercises for spastic hemiparetic child. This agrees with Ubinger (1999)[42], who assessed stability index scores following closed kinetic chain exercises. There was improvement noted in the form of the decrease in scores which was relegated to sensitization of heightened awareness due to repeated exposure to the open and closed chain activities performed for four weeks of intervention. The closed kinetic chain activities mainly involved a quadruped position and the use of a wobble board and small air filled mat. As a time comparison, the closed kinetic chain training significantly

affected neuromuscular control of the upper extremity.

Improvement of post-treatment mean values of angular error of 15° and 30° wrist extension, this comes in agreement with Hatches (2005)[20], who revealed the effects of the traditional physical therapy program on improving proprioception as some exercises used in this program were open kinetic chain exercises in nature such as range of motion exercises and strengthening exercises for the wrist but it loses the training effect of active reproduction and precision of movement in specific directions as in the open kinetic chain exercises designed for proprioceptive training for example the joint position sense exercise. These results mean that the proprioception when lost, it needs to be trained.This result also supported by Matthews (1997)[33], who concluded that proprioception is mostly acquired and trainable.

The significant improvement detected in the post treatment results of study group may be attributed to, improvement of the child ability to combine a pattern of stability and mobility. This come in agreement with Hatches et al. (2005)[20], who stated that, it is important to add the open and closed kinetic chain exercises proprioceptive exercises for the program of the rehabilitation for the wrist and hand of spastic hemiplegic cerebral palsy children. This will lead to more improvement in wrist proprioception and stability in order to prevent injuries and more deterioration in function and stability. Therefore, adding the proprioceptive training to the program of the rehabilitation of children with cerebral palsy, has great importance in avoiding unphysiological joint movements such as extreme extension and flexion[23].

The obtained post treatment results after six months of treatment come in agreement with Guyton and hall[19], who stated that proprioceptive input can influence multiple levels of central nervous function. These levels of potentially modulate muscle tone through many mechanisms as pre-synaptic and post-synaptic activity, neuropeptide and controlled inhibition.

Also the result was supported by Prentice (1999)[36], who reported that for normal wrist, proprioception must be restored in addition to joint range of motion, flexibility, muscular strength, and muscular endurance. Therefore, adding the proprioceptive training to the traditional physical therapy program for rehabilitation cerebral palsy children is a necessity in order to restore proprioception. Studies are unfortunately lacking the effect of proprioceptive training on different conditions of the wrist joint but our result is supported by similar studies applied on different joints as in Blackburn (2000)[4].

The results obtained from this study after the suggested period of treatment, clearly demonstrated the effect of proprioceptive training in the form of OKC and CKC exercises on achievement of upper limb motor control by providing a more normal sensory-motor base and alternation of wrist proprioception and hand function abilities in children with hemiparesis.

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الملخص العربي

تأثير تمارين السلسلة المفتوحة و المغلقة على الإحساس العميق للرسغ وقدرات وظائف اليد في حالات الأطفال المصابين بالخدل الشقي

خلفيه البحث و الهدف : الشلل المخي للمصابين بالخدل الشق ه و النوع الأكثر شيوعا من الشلل المخي . وظيفة الجانب المصاب تتأثر بأنماط غير طبيعية للعضلات،تغير في الإحساس العميق ، قلة سرعة الحركة ، فقر وظائف القبض والإفراج . مهارات اليد حاسمة بالنسبة للتفاعل مع البيئة . إنه يسمح لنا بالتعاون مع عالمنا من خلال أجسامنا وأجسام الآخرين ومن خلال التعامل مع الأشياء بينما ألإحساس العميق هو العملية التي عن طريقها يتفاعل الجسم لتغيير وضع المفصل . بالمقارنة بالخلل الحركي فـي أطفال الشلل المخي المصابين بالخدل الشق ي ، هناك اهتمام أقل موجه لعيوب معالجة رد الفعل الحسي . يتضمن هذا معلومات الحس العميق الخاصة بوضع مفصل الرسغ . تمت هذه الدراسة للتحقق من تأثير تمرينات السلسلة المفتوحة و المغلقة على التغير في الإحساس العميق للرسغ و وظيفة اليد في أطفال الخدل الشقي.
عينة البحث: ثلاثون طفلا من أطفال الشلل المخي المصابين بالخدل الشقي من الجنسين تتراوح أعمارهم بين خمس إلى سبع سنوات ، وقد تم تقسيم العدد عشوائيا إلى مجموعتين متساويتين المجموعة الحاكمة (أ) ومجموعة الدراسة (ب) . تتراوح درجة التشنج في العضلات من 1 إلى 1+ تبع مقياس أشوارث المعدل . الطرف العلوي المصاب كان حر من أي تشوهات تكوينية. مع ذلك أظهرت الأطفال درجات متغيرة من قصر العضلات. تم تقسيمهم عشوائيا إلى مجموعتين متساويتين في العدد (أ) مجموعة حاكمة و (ب) مجموعة اختبارية . طريقةالبحث: تم التقييم قبل وبعد ستة شهور من العلاج لكل طفل من المجموعتين . تم استخدام مقياس مدى الحركة الكهربي لتقييم الخطأ الحسي العميق من خلال اختبار الإنتاج الإيجابي للوضع الإيجابي وتقييم وظائف اليد المصابة بمقياس بيابودى لاستخدام اليد . تلقت المجموعة أ برنامج العلاج الطبيعي المعتاد بينما تلقت المجموعة ب نفس البرنامج الذ ي تلقته المجموعة أ مضافا إليه برنامج تمرينات السلسة المفتوحة و المغلقة.
النتائج: أظهرت نتائج البحث عدم وجود فروق ذات دلالة إحصائية بين جميع المتغيرات عند مقارنتها قبل العلاج في المجموعتين بينما كان هناك تحسن ملحوظ في كل المتغيرات في المجموعتين عند مقارنه النتائج قبل و بعد العلاج. كما وجد فروق ذات دلاله إحصائية عند مقارنه نتائج المجموعتين بعد العلاج لصالح مجموعه الدراس ة (ب). المناقشة والاستنتاج: يفضل إضافة تمريتات السلسلة المفتوحة والمغلقة مع برنامج التمرينات العلاجية لتحسين الإحساس العميق للرسغ و وظيفة اليد في الأطفال ذات الخدل الشقي .
الكلمات الدالة: الشلل المخي للمصابين بالخدل الشقي ، تمرينات السلسلة المفتوحة والمغلقة ، الإحساس العميق للرسغ ، وظيفة اليد .