IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e- ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 7, Issue 2 Ver. VIII (Mar-Apr .2018), PP 84-92
www.iosrjournals.org

Efficacy of Hand Arches Training In the Improvement of Dynamic Tripod Grasp and Handwriting Skills in Hemiplegic C.P. Children.

[1]. Ahmed M. Azzam*
Department of Physiotherapy for Developmental Disturbance and Pediatric Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt.
*Correspondence Author: Ahmed M. Azzam**

Abstract: *Objectives: This work was carried out to investigate the efficacy of hand arches training in the improvement of dynamic tripod grasp and handwriting skills in hemiplegic C.P. children. Method: 30 children were joined in this study and at random selection divided into two groups; group A (hand arching training plus popular physiotherapy program) and group B (popular physiotherapy program only). Motor accuracy test was used to locate and follow eye-hand coordination, hand manipulation test to locate and follow translation, shifting and rotation tasks ,functional writing skill was used to locate and follow writing abilities and pinchmeter to locate and follow pinch grasp motor control . Results: The variance between pre and post-treatment results was highly significant in the study group in all variables. By comparison of the two groups in motor accuracy test at post-treatment, there was a highly representative elevation in eye-hand coordination related to study group (p<.05). There was a highly representative elevation in translation and rotation related to study group (p<.05). By comparison of the two groups in functional writing skill at post-treatment, there was a highly representative elevation in writing abilities related to study group (p<.05). By comparison of the two groups in pinchmeter test at post-treatment, there was a highly representative elevation in pinch grasp motor control related to study group(p<.05). According to the outcomes of this study, it can be terminated that the combined effect of hand arching training plus routine regular physiotherapy program can be recommended in improvement handwriting skills in hemiplegic C.P. children .*

***Keyword**: hand arches- dynamic tripod grasp - handwriting skills –cerebral palsy*

Date of Submission: 09-04-2018 Date of acceptance: 23-04-2018

I. Introduction

Upper extremity impairment in hemiplegic C.P. is the major residual dysfunction when the middle cerebral artery is the reason for stroke in hemiplegic cerebral palsy. The recovery of the upper limb in hemiplegic C.P is an indicator of good prognosis because hand function and shoulder movement is the keystone of activity of everyday living.1,2,3

Well developed hand arches improve hand motor control via coordination between hand stability and mobility mechanisms. There are 2 transverse arches(by the carpal bones and distal ends of the metacarpal bones) and 4 longitudinal arches(by the finger bones and their associated metacarpal bones) plus 4 oblique arches(between the thumb and four fingers) in the hand. There are 3 main arches in hand distal and proximal arch plus longitudinal arch. The proximal arch is considered the most rigid arch because the arch originates from the carpal bone. The distal one is flexible and arises at the metacarpal heads allowing the hand to be flattened while being opened. The longitudinal arch run along 2nd and 3rd metacarpal bones along middle and index fingers. It is mobile arch specifically in distal part. All these arches work well organized to reshaping, flattening and cupping of the hand this lead to raise the exposed surface of the hand and increase the sensory tactile input leading to increasing hand motor control. The little and ring finger represents the stability part of an arching mechanism allowing the mobile part(index-middle finger- thumb) to perform its fine précising hand grasp. The organization between stability and mobility parts of the arching mechanism producing qualified skill. which allowing the hand to control the skill parameters and intrinsic muscles strength.4,5,6

The thumb serves as a leader for hand fingers due to the presence of the web space. It forms 4 diagonal arches with other fingers. The valuable one is within thumb and index finger due to it permits for precise and delicate hand grasp. Arch from thumb to little finger perform a locking system for the power grasp. Thumb with index and middle fingers are responsible for most fine motor precise skills. Besides little and ring fingers are required in stabilization and power skills.7

Hand writing, cutting with scissors and pencil grasp are pre-school related skills in a bad need for hand arches development first to perform stabilization mechanism of the pinky side in the form of little and ring finger which curled in a palm or out stretched to allow free movment of thumb ,index and middle finger also stabilization of trunk, elbow and wrist joints with forearm rotation additionally second need is the mobility of shoulder joint and middle ,index and thumb fingers allowing for precision motor skill as pencil grasp for facilitating hand writing plus wrist extension with stabilization and reciprocal inhibition within agonists and antagonists of upper limb muscles to produce smooth hand writing skills.8 The evolution of hand arch occurs firstly in crawling due to weight bearing on the static pinky side of the hand while the mobile side(thumb, index, and middle fingers) perform the precision grasp. Inhibition of movement to the pinky side occurs while facilitation of movement to mobile side occurs under the motor control mechanism. Impaired forearm neutral position or supination which is the most vital physical movement affecting on handwriting skill due to it allows the thumb to face upward producing precision hand grasp and other hand functions on the contrary pronation of the forearm allow the thumb facing down losing its ability to produce fine precision grasp with other fingers.8

Impaired hand somatosensory information induce losing of pencil grip skill also poor writing skills may arise from a decrease of hand somatosensory feedback. Delayed handwriting skills in hemiplegic C.P. originate mainly from immature pencil grasp evolution due to impaired hand somatosensory feedback.9,10

II. Material and methods

Subject:

30 children from the two sexes with hemiplegic C.P. children were joined for this study, aged 6 to10 years at the time of recruitment because the children in this age could cooperate and understand the instructions and guidelines of the research work. Body weight, height, and side of affection, type of involvement, level of ambulation were recorded for each subject. The excluded criteria include children who had previous surgery to the upper limb.

Children were randomized to the study group (A) 15 children received the (hand arching training) plus routine regular physiotherapy program while other 15 children of the control group (B) subjected to routine regular physiotherapy program only.

III. Outcome measurement

1-Motor accuracy test:

It was designed to measure eye-hand coordination via tracking the item and doting to evaluate stop-start-placing movement and the child asked to visually track the curved black lines by his red marker on the standard sheet that can be graduated to more difficult form. The distance between black lines and red lines were calculated and we tacked the average of deviated distance after 3 trials on 10 blacked lines on standard sheets. The speed of performance was determined by subdividing the deviated distance by the time of performance .11

2-Functional writing measurement:

It could be evaluated by writing speed test which calculated as the sum of letters copied that they succeeded in writing per minute. The performance of speed increased with age. 12

3-Hand manipulative skills evaluation:

There are different factors that influence on translation and rotation tasks of hand manipulation as opened web space, isolate and grade finger, thumb opposition, efficient intrinsic muscles of the hand, proximal stability, finger prehension and adequate palmar arches. In the translation task, the child picks up the pegs from the table by his fingers and shifted it to the palm then asked to translate it from palm to fingers releasing them one by one again to the pegboard. The time of 3, 4 and 5 pegs translation was recorded. The second task of hand manipulation was the rotation where the child asked to pick up on the peg and turn it over by the fingers and place it in its hole 3 trials were performed and the time of performance was recorded from the average of the 3 trials. The scores performance of translation and rotation tasks were evaluated by the time required to finish the task recorded in seconds.13,14,15

4-Pinchmeter:

It was designed to measure the pinch grasp strength which indicates to the tripod pencil grasp motor control. We asked the child to squeeze the pinchmeter by the first 3 fingers index and middle fingers pads from one side and the thumb pad from another side. Three trials were performed by the children and average scores were recorded.16

Determination of the developmental stage of pencil grasp is the first line of evaluation. Most of hemiplegic CP children suffering from static tripod grasp in which pencil is supported by radial side of the middle finger and the purple of index rested on appearance side of the pencil also the thumb is completely opposed on the pencil plus mild wrist extension and forearm placed on the table hand move as a unit(no localized movement). We encourage the dynamic tripod grasp(gold standard handwriting grasp) because it is the uppermost efficient form of pencil grasp in which pencil is supported by the radial side of the third finger with the pulp of the index and thumb on the top side of the pencil with open web space. Stabilization by little and ring fingers occur by flexed position into the palm to support the distal transverse arch and the third finger during pencil grasp this allow for localized movement to occur.

IV. Intervention

The two groups (A and B) received an popular physiotherapy program, as the following:

1. Hot packs to improve circulation and decrease the severity of tightness applied to the upper limb muscles as long as 20 minutes.
2. Facilitation of anti-spastic muscles (extensors of upper limb and flexors of lower limbs): facilitate muscle contraction by (tapping, apply fast and short stretch ,facilitate protective reaction by produce painful stimuli of L.L to inhibit extensor spasticity, increase muscle pull via bearing the weight ,proprioceptive training , musculotendinous junction sensory stimulation, firing of motor neuron pool by junderasic maneuver and irradiation and brief time icing).
3. Prolonged stretch to inhibit released abnormal pattern and decrease the degree of spasticity (antispastic positioning, static splint, inhibition of released abnormal pattern and NDT) for 20 minutes.
4. Passive stretching to tight muscles (wrist flexors+ biceps brachii +pronators+ iliopsoas and rectus femoris and adductors+ hamstring+ tendon-Achilles muscles) to destruct adhesions in muscles and sheath. It must be a decent gentle gradual stretch not over stretch at all, lasting 20 seconds then relaxation 20- seconds 3-5 times per session then maintain the new range by using an adjustable splint.
5. Graduated active exercise for trunk muscles.
6. Walking training using aids in a closed environment using obstacles, side walking followed by pass walking to stimulate protective reaction.
7. Balance training program which includes static and dynamic training.
8. Faradic stimulation of anti-spastic muscles. To prevent cross electricity to reach spastic muscles because these higher excitable tissues are more attractive to respond to electric stimulation than the less excitable. Mother was asked to support wrist and foot in function positioning during NEMS for 15 minutes.

The experimental group (group A) received hand arching training program as following:

Well developed arches provide hand with the capacity to shape the hand, to grip variously shaped and sized objects, control the skilled movement of the fingers and degree the power of prehension. Well-developed arches allow the palm to design a deep hollow at the base of the long finger and recognizable crease between the thenar and inflated hypothenar eminences when the hand is cupped. Hand arches can be evaluated by searching about the depth of the palm and wrinkles of the muscles along the pinky side when using Shaking dice with cupping the hands., Make spiders on a table with their fingers and touching the thumb to pinky side several times and release. Distal transverse arch represents a biomechanical quantitative measure to the palmar cavity which reshapes itself to be suitable for the object characteristics.17,18

Facilitation of hand arching:

1)- Occupational Tools used in the facilitation of hand arching:

- Tongs activities ,Cutting scissors activities ,Broken crayons training ,Clothing fasteners activities ,Training consists of squeezing of a clothespin ,Stringing beads training ,Theraputty activities ,Multi pegs activities ,Eyedropper training
- Squirt bottles training ,Plastic knife cutting training ,Palm shaping and loading activities ,Shaking dice training ,Tower building training , and Theraplast balls training .19

2)- Facilitate proprioceptive training to increase hand sensory awareness via weight bearing on hands and knees. Hand weight bearing ex. either activity that bears on hands or activity that push by hands.20,21,22

Proprioceptive training by hand weight bearing ex. could be performed in different positions:

1**- Prone:**

- Bilateral weight bearing on both elbows
-Then unilateral weight bearing on one elbow.
-Bilateral weight bearing on both hands
-Then unilateral weight bearing on one hand

-Gradually raising of both legs bearing on both hands then on one hand. Then reciprocal upper limb movement with elevations of both legs
-Prone to bearing on the elbow with supination and pronation

2-**Side sitting**:
- Unilateral weight bearing on one flexed elbow then the other
-Unilateral weight bearing on one hand then the other

3-**Quadriped:**
-Bilateral weight bearing on elbows then unilateral
-Bilateral weight bearing on hands then unilateral.

4-Sitting:
-Bearing body weight on affected hand with the other hand support on it.
- The bilateral pressure of both hands against the table then unilateral pressure

5-Standing:
-Bearing weight on both hands then unilateral
-The bilateral pressure of both hands on therapist's hands then unilateral pressure
-The bilateral pressure of both hands on the table then unilateral .23

3)-Facilitate precision grasp by support forearm on table with encouraging pick up first large then small object, rough then smooth, heavy then light, rectangular then circular. on the rough or rubbery surface then smooth surface.

4)-As above but trying to put them into the container.

5)- Facilitate cutting scissor skill by using a plastic knife, automatic scissors

6)-Facilitate precision grasp by opening-close doorknob several times.

7)- Rolling of the towel under the palm using fingers.

8)- Facilitate power grasp in the open environment via catching and throwing plus hammer training.

9)-Facilitate transfer activity of hand during balance(motor learning stages: (reacquisition of skill- rotation – transferring)

10)-Eye-hand coordination activities (e.g., cutting, lacing, stringing beads, completing finger mazes) may lead to improvement in handwriting performance. 24

11)-Visio-motor integration training via progression levels of difficulty starting with the easiest which is scribble. The second step was an imitation of drawing and the most difficult stage was copying difficult geometric forms.25,26 Such as Imitate marking, Spontaneous marking, Contained marking. Vertical line (imitate), Horizontal line (imitate), Circle (imitate), Vertical line (copy) , Horizontal line (copy) , Circle (copy) , Vertical horizontal cross, Right oblique line, Square , Left oblique line, Oblique cross , Triangle, Open square and circle, Open square and circle, Three-line cross, Directional arrows, Two-dimensional rings, Six-circle triangle, Circle and shifted square, Vertical diamond, Tilted triangles, Eight-dot circle, Horizontal diamond., Three-dimensional rings , Necker cube , Tapered box and Three-dimensional star.27

V. Result

Patients' characteristics.

The first table displays the patient's characteristics. There were 11 boys (36,66%) and 19 girls (63.33%) and in regarding side of affection reported in 14 patients (46.67%) RT hand affection and 16 patients (53.33%) were left-hand affection. There was no representative difference in all children in regarding age (p=0.2990), in regards to sex (p= 0.2712) and in regarding side of affection (p= 0.1534).

Table 1: Patients' characteristics.

Variables	Study group N=15	Control groupN=15	P-value
Age	8.13±1.36	7.60±1.40	0.2990
Sex N% Boys Girls	7 (46.67%) 8 (53.33%)	4 (26.67%) 11 (73.33%)	0.2712
Side of affection% Right Left	9 (60%) 6 (40%)	5 (33.33%) 10 (66.67%)	0.1534

Changes in eye-hand coordination:

Mean test scores and SD for the two groups are displayed in table 2. The mean record of eye-hand coordination variable in both groups (assessed by motor accuracy test) at baseline measurement (pre-treatment) was insignificant (p>0.05) while significant at post-treatment (p<.05).Besides study group had a highly statistical progress in eye-hand coordination post-treatment (p<.05)in contrast there is no statistical progress in the treatment group. The average progress of eye-hand coordination variable tended to be highly represented of the study group (2.40±1.12versus3.60±1.64, p=0.0001) while insignificant result in the control group (3.67±1.59versus3.87±1.60, p = 0.0824). The proportion of progress of eye-hand coordination was (33.33%) in the study group while it was (5.17%) in control group.

Table 2: The average test of eye-hand coordination variable in both groups.

Eye-hand coordination variable	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	3.60±1.64	3.87±1.60	0.6553
Post-treatment	2.40±1.12	3.67±1.59	0.0176
Improvment%	33.33%	5.17%	0.0001
P-value (within groups)	0.0001	0.0824	

Functional handwriting changes:

Mean test scores and SD for all hemiplegic children are displayed in table 3. The mean record of functional handwriting variable in the two groups (assessed by numbers of letters /minute) at baseline measurement (pre-treatment) was insignificant (p>0.05) while being significant at post-treatment (p<.05). The average improvement of functional handwriting variables moves toward being highly represented of the experimental group (7.93±.1.67versus 6.64±1.45, p=0.0001) while insignificant result in the control group (6.73±1.49versus 6.60±1.68, p= 0.1643). The proportion of progress of functional handwriting variable was (19.5%) in the study group while it was (1.97%) in control group.

Table3: The average test of functional handwriting variable in both groups.

Functional handwriting variable	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	6.64±1.45	6.60±1.68	0.6637
Post-treatment	7.93±.1.67	6.73±1.49	0.0468
Improvment%	19.5%	1.97%	0.0019
P-value (within groups)	0.0001	0.1643	

Pinch grasp motor control variable changes:

Mean test scores and SD for all hemiplegic C.P. children are displayed in table 4. The mean record of pinch grasp variables in the two groups (assessed by pinchmeter) at baseline measurement (pre-treatment) was insignificant (p>0.05). The average progress of pinch grasp variables move toward being highly significant in the experimental group (2.20±0.68versus1.53±0.52, p=.0.0001) while significant result in the treatment group (1.73±0.59versus1.47±0.52, p= 0.0406). The proportion of progress of pinch grasp variable was (43.8%) in the study group while it was (17.69%) in control group.

Table4: The average test of pinch grasp variable in both groups.

Pinch grasp variable	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	1.53±0.52	1.47±0.52	0.7263
Post-treatment	2.20±0.68	1.73±0.59	0.0543
Improvment%	43.8%	17.69%	0.0929
P-value (within groups)	0.0001	0.0406	

Hand manipulation variables changes:
Translation variable changes:
Mean test scores and SD for all hemiplegic C.P. children are displayed in table 5. The mean record of translation variables in both groups (assessed by the time of performance) at baseline measurement (pre-treatment) was insignificant (p>0.05). The average progress of translation variables moves toward being highly represented in the experimental group (5.73±1.53versus7.20±1.61, p=.0.0001) while insignificant result in the treatment group (6.53±0.99versus6.87±0.92, p= 0.1362). The proportion of progress of translation variable was (20.4%) in the study group while it was (4.9%) in control group

Table 5: The average test of translation variable in both groups.

translation variable	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	7.20±1.61	6.87±0.92	0.4920
Post-treatment	5.73±1.53	6.53±0.99	0.1008
Improvment%	20.4%	4.9%	0.0052
P-value (within groups)	0.0001	0.1362	

Rotation variable changes :

Mean test scores and SD for all hemiplegic C.P. children are displayed in table 6. The mean record of rotation variables in both groups (assessed by the time of performance) at baseline measurement (pre-treatment) and(post-treatment) was insignificant (p>0.05). The average progress of rotation variable moves toward being highly represented in the experimental group (4.07±1.16versus 4.87±1.36, p=.0.0001) while insignificant result in the treatment group (4.60±1.76versus 4.47±1.73, p=0.1643). The proportion of progress of rotation variable was (16.4%) in the study group while it was (2.9%) in control group.

Table 6: The average test of rotation variable in both groups:

rotation variable	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	4.87±1.36	4.47±1.73	0.4862
Post-treatment	4.07±1.16	4.60±1.76	0.3368
Improvment%	16.4%	2.9%	0.0009
P-value (within groups)	0.0001	0.1643	

VI. Discussion

There are different neurological pre-requisites that provide an efficient motor control on handwriting skills as hand proprioception, eye-hand coordination, motor planning, visual motor integration and hand manipulation (precision translation and precision rotation).24,28,29 Also there are numerous biomechanical elements that affect on handwriting skills as a separate both sides of the hand, and open and stabilize the thumb-index web space, isolated finger movement ,thumb opposition ,distal finger prehension and adequate palmar arches(Floppy hand is the result of loss stability of the hand due to weak or lost arches).30

The somatosensory input from the hand allows for efficient handwriting skills. Because these sensations provide CNS by direction of joint movement, joint position beside the weight of the objects. Its feedback information is more important than visual feedback because its information is more accurate and immediate for gaining the precision movement.30 Efficient hand kinesthesia provides CNS by sensory awareness of the weight of object and weight of limb plus the direction and position of moved joint(sense of position and sense of movement). Limited hand somatosensory feedback produce inefficient motor planning and sequencing of handwriting skill .31,32,33

Dynamic tripod grasp could be encouraged by facilitation firstly the palmar grasp by using large-sized pencil which is held by palm and other fingers(by holding different size, shape, weight and texture of pencil material) till the palmar grasp was developed. The next step by facilitation of radial grasp by moving of the large pencil toward the thumb, index and middle finger so thumb and fingers hold large pencil against the palm.

The third step holding the large pencil with all fingers pads. The last step by direct the holding with pads of the thumb, index and middle finger.32

Developmental Stages of pencil grasp including 1- Fisted hand grasp: present at age 1-1.5 years. hold a crayon in fisted hand as they pick up a knife and fork moving it by shoulder movement. 2- Palmer Grasp: presented at age 2-3 years. Moving by this grasp which is identical to that of using a knife and fork to cut food which is maintained by shoulder movement. 3-Static Tripod: presented at age 3.5-4 years .It occurred by hold pencil with all five fingers resulting in the wrist being off the table. Movement of this grasp come from the wrist due to the fingers is not still independent. 4-Dynamic Tripod grasp: presented at age 4 – 6 years, in this stage fingers move independently. the grasp occur by thumb, index and middle fingers with flexion of little and ring fingers.34

This Dynamic Tripod grasp required the thumb to be in opposition with open web space which intrinsic muscles to do well in precision and controlling the pencil grasp plus less effort required for writing leading to less tiredness on the joints and increase the time of writing (Fig.1).

Fig.1 Dynamic Tripod grasp . 35

The pencil grasp graduations should be achieved by using progression level of the tools used in the activation of dynamic tripod grasp. The pencil, crayons, chalks should be big, rectangular, heavy, rough tools it is the uppermost easiest grasp graduation we can give the child extra, prolonged duration and decrease the speed of performance to decrease the numbers of trials and increase the degree of accuracy. The surface should be rough or rubbery with graduation to smooth surface and must be performed on the stable surface and it can be graduated to be unstable surface. The reacquisition, rotation and transferring of the skills are the principles to gain pencil grasp skills.36

There are numerous solutions could be performed to help children to gain the school-related skills as (cutting with scissors-hand writing and pencil grasp).When there was weak fingers movement the child could use large shoulder movement with large paper size plus increase time with more slowly performance. When there was weak elbow stability at 90 o during pencil grasp the child could use prone position with a flexed elbow. When there was weak buttoning the child could use big sized buttons. When there was a weak cutting skill the child could use opened automatically scissors.8

Handwriting is a highly intellectual skill that has obtained by reason of higher centers motor control between motor function, visual, perception and cognitive function. Cerebral palsy interferes with gross motor skills(as postural control), fine motor skills, visual perceptual skills and cognitive, attention and organizational skills which interfere with handwriting abilities.37 It depends on the target shape, weight, size, texture of the material, time, speed, accuracy, numbers of trials.38,39 These characteristics of objects affect on the determination of grasp type and arches shaped this grasp.40,41,42

Physiological effects of proprioceptive training for increased hand sensory awareness by.:
Weight-bearing on both hands or more weight on one hand has a vital role in gaining handwriting skill as:
1-It stimulates joint proprioceptors leading to increasing of wrist stability and sensory awareness
2-It stimulates muscle proprioceptors(muscle spindle and Golgi tendon organ) leading to increase motor control of the hand
3- It stimulates Ca++ deposition to the bone leading to increasing of bone density
4- It stimulates muscle pull on weak muscle inducing contraction
5-It produces passive stretch to tight muscle leading to increasing ROM
6- It provides prolonged stretch to spastic muscles leading to its relaxation
7- It provides facilitation of the normal co-contraction between agonist and antagonist
8- It provides preparing an activity to hand functions training
9- It provides facilitation of the reciprocal movement of both UL
10- It provides stimulation of the remodeling mechanism for correction and healing
11- It provides relieving of shoulder and scapular+ pain .43

The position of 4 feet kneeling activate lower trapezius muscle, the teres major muscle, the anterior fibers of the deltoid muscle, and the posterior fibers of the deltoid muscle. More muscle activity gained by unilateral hand weight bearing due to increased weight pressure and the reaction of increased floor pressure.21 Hand weight bearing ex. enhance scapular and rotator cuff stability.44

The vital role mechanism controlling hand function is the reciprocal inhibition mechanism between wrist extensors and flexors leading to efficient grasping function .Motor control of these muscles is the main item in hand functions. In stroke patients, the greatest problem which faces rehabilitation is the spasticity of wrist flexors with the weakness of wrist extensors which induce impairment of reciprocal inhibition mechanism which leads to abnormal coactivation leading to loss of hand grasping skills.45,46

The most important physical movements in controlling hand grasping skills are the supination of the forearm, elbow extension and shoulder and trunk stabilization. Hand weight bearing ex. stimulate upper limb muscles with reciprocal inhibition between flexors and extensors maintaining the elbow and wrist in extension with shoulder stabilization.47,48

VII. Conclusion

According to the outcomes of this study, it can be terminated that the combined effect of hand arching training plus routine regular physiotherapy program can be recommended in improvement handwriting and pencil grasp skills in hemiplegic C.P. children.

References

1. Sharp S. A. , Brouwer B. J. (1997)"Isokinetic strength training of the hemiparetic knee: effects on function and spasticity," *Arch Phys Med Rehabil*, vol. 78, no. 11, , pp. 1231-1236.
2. Radomski M. V. and Tromly C. A. (2002) *Occupational Therapy for Physical Dysfunction*, 5th ed, Lippincott Williams & Wilkins, Baltimore, , pp. 1022-1035.
3. Faria-Fortini I., Michaelsen S.M., Cassiano J.G. and Teixeira-Salmela L.F. (2011) Upper Extremity Function in Stroke Subjects: Relationships between the International Classification of Functioning, Disability, and Health Domains. Journal of Hand Therapy, 24, 257-264. http://dx.doi.org/10.1016/j.jht.2011.01.002
4. Hertling D. and Kessler R. M. (1996) *Management of common musculoskeletal disorders: Physical therapy principles and methods*. (3rd ed.).Philadelphia: J.B. Lippincott.
5. Norkin C.C. and Levangie P.K. (1992) *Joint structure and function.* (2nd ed.). Philadelphia: F.A. Davis.
6. Smith L.K., Weiss E.L. and Lehmkuhl L.D. (1996) *Brunnstrom's clinical kinesiology*. (5th ed.). Philadelphia: F.A. Davis.
7. *Thomine RT , Michel J , Evelyn M , (1998)* Examination of the Hand and Wrist (2nd ed.). Taylor & Francis. ISBN 978-1-85317-544-2.
8. Therapy skill builders ,(1991) Forearm, hand and finger control. A division of communication skill builders/602-323-7500.
9. Schneck C. M. ,(1991) Comparison of pencil-grip partners in first graders with good and poor writing skills. *American Journal of Occupational Therapy*, 45,701-706.
10. Levine M. D., (1987) *DeveLopmentaL variation and learning disorders.* Cambridge, MA: Educators Publishing Service.
11. Ayres A. J., (1989) *Sensory Integration and Praxis Tests.* Los Angeles: Western Psychological Services.
12. Rubin N., and Henderson S.E.,(1982) two sides of the same coins.variation in teaching methods and failure to learn to write.special education:forward trend9:17-24.
13. Ben bow M., (1987) *Sensory and motor measurements of dynamic tripod skill* Unpublished master's thesis, Boston University, Massachusetts.
14. Exner, C., (1995) Remediation of hand skill problems in children. In A. Henderson & C. Pehoski (Eds.), *Hand function in the child: Foundations for remediation* (pp. 197-222). Sr. Louis: Mosby.
15. Myers C. A., (1992) Therapeutic fine-motOr activities for preschoolers. In J. Case-Smith & C. Pehoski (Eds.), *Development of hand skills in the child* (pp. 47-59). Rockville, MD: American Occupational Therapy Association .
16. Mathiowetz V., kashman N., Volland G., Weberk.Dowe M., and Rogers S.,(1985) Grip and pinch strength. Archives of physical medicine and rehabilitation, 66,65-74.
17. Sangole A.P., Levin M.F., (2008) Arches of the hand in reach to grasp. J. Biomech. 41, 829–837.
18. Sangole A.P., Levin M.F., (2008) Palmar arch dynamics during reach-to-grasp tasks. Exp. Brain Res. 190, 443–452.
19. Renbow M., (1995) Neurokinetic approach to hand function and handwriting.
20. Pontillo M. ,Orishimo K. F., Kremenic I. J. , McHugh M. P., Mullaney M. J. and Tyler T. F., (2007) Shoulder musculature activity, and stabilization during upper extremity weight-bearing activities," *N Am J Sports Phys Ther*, vol. 2, no. 2, , pp. 90-96.
21. Chen S. B. , Chang J. Y. and Hsu A. T., (2007) "Kinetics and electromyographic analyses of the shoulder during upper extremity weight-bearing exercises," *Journal of Biomechanics*, vol. 40, vol. 2, , pp. 390.
22. De Araújo R. C. , Tucci H. T. , De Andrade R.., Martins J., Bevilaqua-Grossi D .and de Oliveira A. S.,(2009) "Reliability of electromyographic amplitude values of the upper limb muscles during closed kinetic chain exercises with stable and unstable surfaces," *J Electromyogr Kinesiol*, vol. 19, no.4, , pp. 685-694.
23. Lee S. E., Cho S. H. and Kim K., (2013) The Effects of Weight-Bearing Exercise on Upper Extremity Activities Performance in the Female Stroke atients.*International Journal of Contents, Vol.9, No.1*.
24. Tseng M. and Murray E., (1994) Differences in perceptual-motor measures in children with good and poor handwriting. *Occupational Therapy Journal ofResearch*, 14, 19-36.
25. Beery K. E . and Beery N. A., (2006) The Beery-Buktenica Developmental Test of Visual-Motor Integration with supplemental developmental tests of visual perception and motor coordination: Administration, scoring and teaching manual (5th ed.) Minneapolis, MN: NCS Pearson.
26. VereekenP., (1961) Spatial development. Groningen, the Netherlands: J.B. Wolters.
27. Miranda N.g. , Chui M., Lin L., Fong A., Chan D., (2015) Performance of the Visual-Motor Integration of Preschool Children in Hong Kong. of Preschool Children in Hong Kong. Hong Kong Journal of Occupational Therapy 25, 7e14

28. Tseng M. H. and Cermak S. A., (1993) The influence of ergonomic factors and perceptual-motor abilities on handwriting performance. AmericanJournaLofOccupationaL Therapy, 47, 917-926 .
29. Weil M. and Amundson C. S. ,(1994) The relationship between visio-motor and handwriting skills of children in kindergarten. American Journal of Occupational Therapy, 48,982-988.
30. Benbow M., (1995) Principles and practices of teaching handwriting. In A. Henderson & C. Pehoski (Eds.), *Hand fUnction in the child: Foundations for remediation* (pp. 255-281). Sr. Louis: Mosby.
31. Ayres A. J., (I 972) *Sensory integration and !earning disabilities.* Los Angeles: Western Psychological Services
32. Benbow M., (1990) *Loops and other groups: A kinesthetic writing system.* Tucson, AZ: Therapy Skill Builders
33. Amundson C. S., (1992) Handwriting: Evaluation and imervemion in school serving. In J. Case-Smith & C. Pehoski (Eds.), DeveLopment of hand skills in the child (pp. 63-78). Rockville, MD: American Occupational Therapy Association.
34. Wilkinson L.,(2015) Stages of Pencil Grasp Development The elbowroom center 32 North Brunswick Street Stoneybatter, Dublin E: info@the-elbowroom.com.
35. Schwellnus H., Carnahan H., Kushki A., Polatajko H., Missiuna C. and Chau T., (2013) Writing forces associated with four pencil grasp patterns in grade 4 children. *The American Journal of Occupational Therapy*, *67*, 218–227.
36. Schneck C.M.and Henderson A., (1990) Descriptive analysis of the developmental progression of grip position for pencil and crayon control in non-dysfunctional children. Am j occup. ther.;44:893-900.
37. Taylor N.F., Imms C., and Dodd K., (2010) physiotherapy and occupational therapy for people with cerebral palsy.https://books.google.com.sa
38. MacKenzie C.L. and Iberall T., (1994) The grasping hand. Elsevier Science B.V, Amsterdam.
39. Morasso P., (1983) Three-dimensional arm trajectories. Biol. Cybern. 48, 187–194.
40. Gentilucci M., (2002) Object motor representation and reaching–grasping control. Neuropsychologia 40, 1139–1153.
41. Goodale M.A., Meenan J.P., Bülthoff H.H., Nicolle D.A., Murphy K.J. and Racicot C.I., (1994) Separate neural pathways of object shape in perception and prehension. Curr. Biol. 4, 604–610 .
42. Jakobson L.S., Goodale M.A., (1991) Factors affecting higher-order movement planning:a kinematic analysis of human prehension. Exp. Brain Res. 86, 199–208.
43. Nawoczenski D. A. , Riek L., Greco M. L. , Staiti K and Ludewig P. M. , (2012) "Effect of shoulder pain on shoulder kinematics during weight-bearing tasks in persons with spinal cord injury," *Arch Phys Med Rehabil*, vol. 93, no. 8, , pp. 1421-1430.
44. Kim S. M .,(2000)"The shoulder pain in hemiplegia after stroke," *Ulsan College UC Report*, vol. 27, no. 2, , pp. 595-613.
45. Ada L. ,'Dwyer N. O .,Green J., Yeo W. and Neilson P., (1996) "The nature of the loss of strength and dexterity in the upper limb following a stroke," *Human Movement Science*, vol. 15, no. 5, , pp. 671-687.
46. Shirley A., Sahrmann., Barbara J. and. Norton B. S.,(1997) "The relationship of voluntary movement of spasticity in the upper motor neuron syndrome", *Annals of Neurology*, vol. 2, no. 6, , pp. 460-465
47. Renner C. I. , ungert-Kahl P. B. and Hummelsheim H., (2009) "Change of strength and rate of rising of tension relate to functional arm recovery after stroke," *Arch Phys Med Rehabil*, vol. 90, no. 9, pp. 1548-
48. Mercier C. and Bourbonnais D.,(2004)"Relative shoulder flexor and handgrip strength is related to upper limb function after stroke," *Clin Rehabil*, vol. 18, no. 2,pp. 215-221 .

Ahmed M. Azzam "Efficacy of Hand Arches Training In the Improvement of Dynamic Tripod Grasp and Handwriting Skills in Hemiplegic C.P. Children.”.” IOSR Journal of Nursing and Health Science (IOSR-JNHS) , vol. 7, no.2 , 2018, pp. 84-92.