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The Effect of Bilateral versus unilateral reaching forward On Attention Concentration in Patients with stroke

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Abstract : Background: Impairment of the upper limb function in stroke patients is the main problem of those patients. Attention concentration also has an impact on the performance of the upper limb function. Finding new method for improvement of the upper limb function and attention concentration is main target of this paper. **Purpose of the study:** to compare the effectiveness of bilateral versus unilateral reaching forward on attention concentration and arm function in stroke patients **Methods:**Thirty male chronic stroke patients with moderate impairment of function of the left upper extremity were assigned into two equal groups. Patients in group 1(G1) received task oriented in form of unilateral reaching forward in addition to attention concentration by rehacome training while patients in group 2(G2) received task oriented in form of bilateralreaching forward in addition to attention concentration by rehacome training. Assessment of the impairment of the upper limb function and attention concentration were done two times before and after eighteen sessions of training by Fugle-Meyer motor performance scale(FMAS) and rehacom**Results :**The training program of the patients in G2 showed a significant decrease of the time needed for attention concentration after bilateral reaching forward.The training program of the patients in G2 showed also a significant increase of the motor performance of the affected upper extremity after bilateral reaching forward .**Conclusion:** Bilateral reaching forward has a favorable effect on the motor performance of the affected arm and also on the attention concentration in patients suffering from chronic stroke.

Key words: Bilateral reaching forward – Unilateral reaching forward – Rehacom- FMAS- Attention concentration.

Introduction

Stroke is a major cause of functional disabilities and decrease in quality of life .cerebral vascular accident (CVA) results in chronic limitations of upper-limb use even after several months of rehabilitation[1].Decreasing in the attention concentration is a common problem also after stroke and one of the leading cause of impairment of the function and decreasing the response of the rehabilitation[2,3,4].

Bimanual movement training (BMT) is a complimentary tool in neuro-rehabilitation of patients with stroke. It includes multiple bilateral training techniques all of them requiring the simultaneous use of both upper-limbs in rehabilitation. Advanced justifications for BMT were grounded on the existence neurally-mediatted dependencies between limbs and also on interhemispheric interactions along with the occurrence of bimanually triggered activation of similar neural distributed networks in both hemispheres as forward reaching[5,6,7].

The primary aim of BMT strategies has been to enhance the recovery of the paretic limb and also the concentration of the patients. Bimanualreaching forward is closer than unimanual practice to everyday tasks[8,9,10].However, BMT as bimanual reaching forward is expected to maximize functional recovery, Consistent findings regarding bimanual reaching forward are still lacking especially for its effect on attention concentration so it is the purpose of this study .

2.Subjects and Methods:

2.1.subject selection:

The study was conducted on two groups:

Group I (G1): Consists of fifteen male of left chronic stroke patients. The patients in this group were treated by unilateral reaching forward in front of mirror from a sitting position in addition to attention concentration training by rehacom apparatus. The Physiotherapist helped the patients to do action of reaching if the patient could not perform it.

Group II (G2): Consists of fifteen male of left chronic stroke patients. The patients in this group were treated by bilateral reaching forward in front of mirror from a sitting positionin addition to attention concentration training by rehacom apparatus. The Physiotherapist helped the patients to do action of reaching if the patient could not perform it.

All the patients of both groups were referred from a neurologist. The diagnosis was confirmed by MRI or CT scan. The patients were selected from the Out-Patient Clinic, Faculty of Physical Therapy, CairoUniversity. After receiving an extensive explanation about the protocol, all the patients were gave an informed consent to the study.

The inclusion criteria were:

An ischemic stroke started since twelve to twenty months at the time of involvement to this study. The age of the patients ranged from 45-60 years old. Each patient had a sustained single cerebro-vascular accident (CVA) of an ischemic type at the right hemisphere .The diagnosis based on the medical history and confirmed by CT scan or MRI. The patients had the ability to follow the simple instructions .All the patients were right handiness. The patients had a volitional control of the non- paretic arm, and can press the button of the rehacom apparatus. All the patients had a moderate impairment for the upper extremity according to Fugle –Myer assessment scale (FMAS). The scores of upper limb impairment were ranged from (19-40)[11].

The exclusion criteria were:

Patients with aphasia, symptomatic cardiac failure or unstable angina. Patients with uncontrolled hypertension (>190/110 mm Hg), significant orthopedic or chronic pain conditions. Patients with significant musculotendinous or bony restrictions of the affected upper limb like (Severe elbow or finger contractures that would preclude passive ROM of the arm). Patients had an affected sided neglect, perceptuomotor or visual field deficits, apraxia and shoulder subluxation.

2.2.The assessment tool:

All the patients were subjected to complete neurological examination of detailed medical history, motor, sensory and ADL examination. The impairment of the function of the affected upper limb was assessed by FMAS while the attention concentration was measured by rehacom apparatus.

Fugle-Meyer assessment scale (FMAS):

The upper extremity section test of (FMAS) was used to assess the degree of impairment of the upper limbmotor function. It is a valid and reliable test. It correlates well with inter joint UE coordination of stroke patients. It has a top score of 66 for UE section

Rehacom system which is a comprehensive and sophisticated system of procedures for computer –assisted cognitive assessment and rehabilitation. Rehacom is soft ware package that helps to assess and train different cognitive areas. The procedures had been developed for the assessment and treatment dimension of attention concentration. The patients were sitting in the front of Rehacom screen at the level of the key board of Rehacom to be able to use it easily. At every session after arm training of both groups ,attention concentration of the patients was assessed for 60 min, 30 min with break of about 10 min between the first and second 30 min and at the next session every times the test was repeated with instruction for the patient to have a score higher than the previous session.

2.3. Training Procedure:

Training procedures for group I:

The patient received the inhibitory techniques first for the spastic muscles. These techniques were applied inform of prolonged stretch to relax the spastic muscles. The patients were treated from a sitting position and in front of mirror where the patient performed unilateral reaching forward with assistance of physiotherapist if needed.

Training procedures for group II :

The patients received the same program as G1 but the patients were instructed to move both limbs syncronsily so the affected limb reached to the same level of the non affected one. Also the patients moved the both limbs at the same speed. The researcher assisted the patients' limb to reach to the level of the non affected one as the patients need.

Rehacom training for both groups:

After training of each group by unilateral and bilateral reaching forward the patients went to do concentration attention test as atrainingexercise by asking the patients to correct the mistakes done in the previous session.

2.4.Data analysis[12]:

For each patient, the following data was collected:

1-The demographic characteristics of the patients were collected and statistically (descriptive statistics) analyzed.

2-Paired and unpaired sample t-testswere used to evaluate the statistical difference within and between the two groups in the attention concentration variable.

3- Mann-whitney U test,it tests whether the samples originate from the same distribution. This test is similar to the parametric unpaired T test. It is used for comparing between two independent samples. Mann-whitney U test was used in this study to detect the significant difference between two groups in the motor of performance from FMAS.

4-The wilcoxon matched pairs test, it tests whether the samples originate from the same distribution. This test is similar to the parametric paired T test. It is used for comparing between two dependent samples. wilcoxon matched pairs test was used in this study to detect the significant difference within each group in the motor of performance from FMAS.

3.Results:

3.1.General demographic data of the patients of (G1) and (G2):

The mean value of age in G1 and G2 were (51.67 ± 4.50) and (51 ± 5.4) years respectively. The mean value of stoke duration in G1 and G2 were (17.57±3.08) and (17.29±2.88) months respectively. Comparison of the mean values of the age (T=.193 and P≤.847) and duration of stroke (T=.150 and P≤.877) between G1 and

G2 revealed that there were no statistically significant differences in the mean values of age or duration of stroke between the two groups of this study (G1and G2).

3.2. The mean values of Fugle-Meyer upper extremity motor performance of pre and post tests in each group:

The mean values of motor performance of G1 at pre and post tests were 25.4±3.77 and25.8±3.17respectively. Comparison of the mean values of motor performance of G1 at pre and post tests showed no significant changing of motor performance over the two period of assessment(P≤.097) **(table 1 and fig.1).**

The mean values of motor performance ofG2 at pre and post tests were 25.1±3.1 and27.86±2.1respectively. Comparison of the mean values of motor performance of G2 at pre and post tests showed a significant changing of motor performance over the two period of assessment(P≤.025) **(table 1 and fig.1).**

3.3. Comparison of the mean values of Fugle-Meyer upper extremity motor performance of pre and post tests between the two groups:

The mean values of motor performance of pre test at G1 and G2 were 25.4±3.77and 25.1±3.1respectively. Comparison of the mean values of motor performance at G1 and G2 showed no significant difference of motor performance between the two groups (P≤.98) **(table 1 and fig.1).**

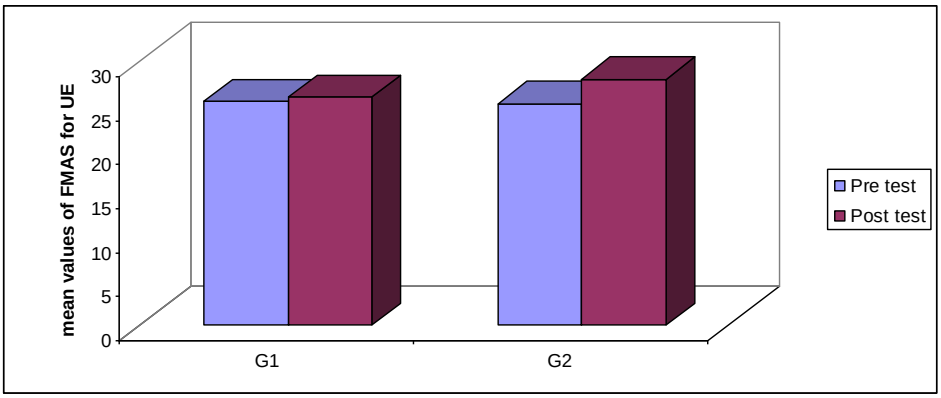
The mean values of motor performance of post test at G1 and G2 were 25.8±3.17and 27.86±2.1respectively. Comparison of the mean values of motor performance at G1 and G2 showed a significant difference of motor performance between the two groups (P≤.005) with best performance for G2**(table 1 and fig.1).**

It is to be concluded that theresults of FMAS for the motor performance of upper extremity (UE) that the training program of G2 had a significant effect on increasing the motor performance of the affected UE in the chronic stroke patients .

Table (1): The mean values of FMAS for the affected upper extremity(UE) of each group:

FMS for affected UE	Mean± SD		Mann-whitney U test	P value
	G1	G2		
Pre test	25.4±3.77	25.1±3.1	.506	.98
Post test	25.8±3.17	27.86±2.1	5.368	.005*
Wilcoxontest	.177	3.111		
P value	.097	.025*		

SD =Standard deviation ***= significant P<.05**



(Fig.1)The mean values of FMAS for the affected upper extremity (UE) of each group

3.4. The mean values of attention concentration (rehacom) of pre and post tests in each group:

The mean values of attention concentration of G1 at pre and post tests were 11.92±2.77 and 11.55±2.17respectively. Comparison of the mean values of attention concentration of G1 at pre and post tests showed no significant changing of attention concentration over the two period of assessment(P≤.19) **(table 2 and fig.2).**

The mean values of attention concentration ofG2 at pre and post tests were 11.82±2.77 and 8.86±2.66respectively. Comparison of the mean values ofattention concentration of G2 at pre and post tests showed a significant changing of attention concentration over the two period of assessment(P≤.005) **(table 2 and fig.2).**

3.5. Comparison of the mean values of attention concentration (rehacom) of pre and post tests between the two groups:

The mean values of attention concentration of pre test at G1 and G2 were 11.92±2.77 and 11.82±2.77respectively. Comparison of the mean values of attention concentration at G1 and G2 showed no significant difference of attention concentration between the two groups (P≤.18) **(table 2 and fig.2).**

The mean values ofattention concentrationof post test at G1 and G2 were 11.55±2.17and 8.86±2.66respectively. Comparison of the mean values of attention concentration at G1 and G2 showed a significant difference of attention concentration between the two groups (P≤.005)**(table 2 and fig.2).**

It is to be concluded that the results of attention concentration by rehacom that the training program of G2 had a significant effect on decreasing the time needed for attention concentration and so improvement in attention concentration in chronic stroke patients.

Table (2): The mean values of attention concentration time by rehacom of each group:

Attention concentration	Mean± SD		P value
	G1	G2	
Pre test	11.92±2.77	11.82±2.77	.18
Post test	11.55±2.17	8.86±2.66	.005*
P value	.19	.005*	

SD =Standard deviation ***= significant P<.05**

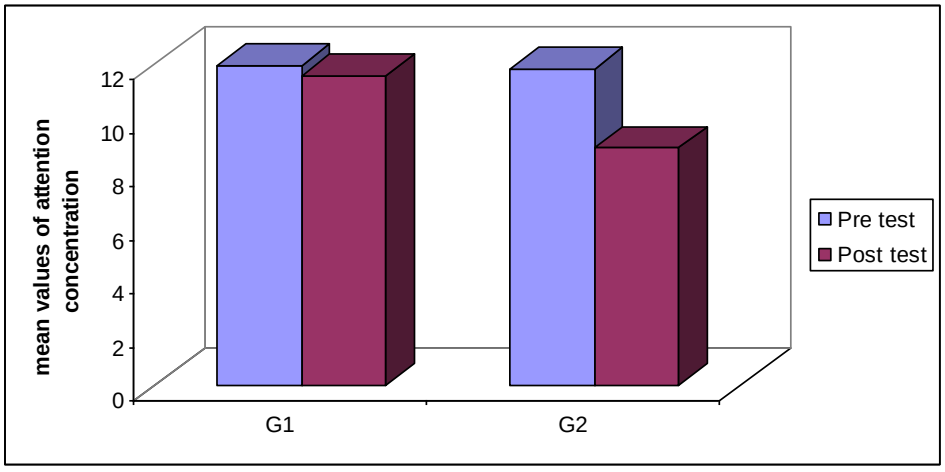


Fig.2The mean values of attention concentration time of each group

4.Discussion:

In the current study, the patients' age ranged from 45-60 years old. It is a common age of the ischemic stroke patients. The degree of plasticity and recovery differs according to patients' age or decades; the younger

patients have a greater plasticity rate than the older one. Age negatively correlates with the functional return so all the patients in the current study were matched for age[13,14]**.**

The selection of the patients was depended also on the side of the stroke. All the patients were left hemiplegia so all the patients in the current study were matched for the site of stroke. The function of the left brain differs from the right one and this affects the level of the motor performance of UE in the chronic stroke patients[15,16,17]**.**

The recruitment of the bilateral brain regions during the bilateral reaching forward provides evidence for an excitatory function of the corpus callosum. It integrates the information between the two hemispheres. Bimanual arm movements enhance interhemispheric facilitation between the primary motor cortex and the premotor cortex. Facilitation of motor learning induces the motor recovery by directly or indirectly increasing the excitability in the ipsilesional motor cortex. This might explain why there is an improvement in arm performance and concentration in this study. This is agreed by**Carson[18].**

It was observed also in other studies that the dorsal premotor cortex (PMd)in monkeys is involved in the control of synergistic axio-proximal movement, cognitive functions such as coding space and associative learning. Reversible inactivation of PMd resulted in an increased number of movement direction errors when the monkey had to respond to a conditional cue with limb flexion or extension as forward reaching in the current study. Bilateral reaching forward increases the excitability of PMd so it is a good method to decrease movement errors in stroke patients and increase the attention and concentration as approved by the results of the current study. This is agreed by **Rose and Winstein[19] and Kidgell et al.[20]**.

Bilateral am training especially reaching forward and back -word retract increases proximal muscles control mainly and has some non significant effect on distal muscles because the proximal muscles at all the time are active . This neurophysiology basis may explain the cause of significant improvement of the affected upper extremity (UE)in the current study This is agreed also by**Calautti and Baron[21] and Burgess et al.[22]**. Repetitive bilateral arm training increases learning skill and M1 representation so it may presume GABAergic M1 disinhibition. Neurons responsible for long-latency intracortical inhibition (LICI) are neuromodulatory controlling of GABA area. They inhibit neurons responsible for Short-latency intracortical inhibition (SICI) pre-synaptically, and also directly inhibit corticospinal output neurons post-synaptically so increasing the learning skill and and attention concentration as in the current study. This physiological explanation of neural excitability and learning skill are agreed also by **Stinear and Byblow [23] and Desrosiers et al.[24] andVardy et al.[25].**

The reason of improving attention concentration in the current study was explained also by**Ameli et al.[26]** who explained the physiological effect of bilateral arm training .Cerebral blood flow of the ipsilesional motor cortex is increased after decreasing the excitability of the unaffected hemisphere which occurs by bilateral reaching forward. This results in wide spreading in the neural plasticity and motor learning where the metabolic changes of the brain promote the neural plasticity and motor recovery after stroke. This metabolic change was proved also by a study of **Johansen-Berg et al.[27]**who used the functional neuroimaging for investigation. This is agreed also by **Takeuchi et al.[28] and Conchou et al.[29] and Rizzo et al.[30]and Grefkes et al. [31]and Takeuchi and Ikoma[32] and Di Lazzaro et al.[33].**

The results consistent also with **Cunningham et al.[34]**who reported that coupling in the bimanual training elicited the smoother movement of the paretic limb when it was coupled with the nonparetic limb in elbow extension movements. This improvement may be due to the Kinematic features of each hand motion that are found in the trajectory of the other hand. The nonparetic limb would exhibit temporal adaptation to that of the paretic limb in both anticipatory and motor control domains for a bimanual symmetrical aiming task. This is consistent with**Kwakkelet al.[35] and Hesse et al.[36]and Luft et al.[37]**.

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7.Conflict of Interest:

The Author(s) declare(s) that there is no conflict of interest.

8.References:

1. Sommerfeld DK, Eek EUB, Svensson AK, Holmqvist LW , Von Arbin MH. Spasticity after stroke: its occurrence and association with motor impairments and activity limitations. Stroke. 2004, 35: 134-139.
2. Murase N, Duque J, Mazzocchio R, Cohen LG. Influence of interhemispheric interactions on motor function in chronic stroke. Ann Neurol. 2004, 55 (3): 400-409.
3. Tur BS, Gursel YK, Yavuzer G, Kucukdeveci A, Arasil T. Rehabilitation outcome of Turkish stroke patients: in a team approach setting. *International Journal of Rehabilitation Research*. 2003;26(4):271–277.
4. Verbunt JA, Seelen HAM, Ramos FP, Michielsen BHM, Wetzelaer WL, Moennekens M. Mental practice-based rehabilitation training to improve arm function and daily activity performance in stroke patients: a randomized clinical trial. BMC Neurol. 2008, 8: 7-10.
5. Beer RF, Dewald JP, Rymer WZ. Deficits in the coordination of multijoint arm movements in patients with hemiparesis: evidence for disturbed control of limb dynamics. Exp Brain Res. 2000, 131 (3): 305-319.
6. Cauraugh JH, Lodha N, Naik SK, Summers JJ. Bilateral movement training and stroke motor recovery progress: a structured review and meta-analysis. Hum Mov Sci. 2010, 29 (5): 853-870.
7. Cincotta M, Ziemann U. Neurophysiology of unimanual motor control and mirror movements. Clin Neurophysiol. 2008, 119 (4): 744-762.
8. Kamper DG, McKenna-Cole AN, Kahn LE, Reinkensmeyer DJ. Alterations in reaching after stroke and their relation to movement direction and impairment severity. Arch Phys Med Rehabil. 2002, 83 (5): 702-707.
9. Ketcham CJ, Rodriguez TM, Zihlman KA. Targeted aiming movements are compromised in nonaffected limb of persons with stroke. Neurorehabil Neural Repair. 2007, 21 (5): 388-397.
10. Whitall J, Waller SM, Silver KH, Macko RF. Repetitive bilateral arm training with rhythmic auditory cueing improves motor function in chronic hemiparetic stroke. Stroke. 2000, 31 (10): 2390-2395.
11. Chen Kuan-Lin ,Chen Cheng-Te , Chou Yei-Tai , Shih Ching-Lin , Koh Chia-Lin ,Hsieh Ching-Lin . Is the Long Form of the Fugl-Meyer Motor Scale More Responsive Than the Short Form in Patients With Stroke?.Archives of Physical Medicine and Rehabilitation. 2014;95(5); 941–949.
12. Marusteri Marius, Bacarea Vladimir. Comparing groups for statistical differences: how to choose the right statistical test? Biochemia Medica .2010;20(1):15-32.
13. Ward NS, Frackowiak RS. Age-related changes in the neural correlates of motor performance. Brain .2003;126(4):873-88.
14. Bagg Stephen, Pombo Alicia Paris , Hopman Wilma. Effect of age on functional outcomes after stroke rehabilitation. Stroke. 2002;33(1):179-185.
15. Wu CY, Trombly CA, Lin KC, Tickle Degnen L. A kinematic study of contextual effects on reaching performance in person with and without stroke: influences of object availability. Arch Phys Med Rehabil. 2000; 81: 95-101.
16. Levy CE, Nichols DS, Schmalbrock PM, Keller P , Chakeres DW. Functional MRI evidence of cortical reorganization in upper-limb stroke hemiplegia treated with constraint-induced movement therapy. Am J Phys Med Rehabil. 2001; 80:4-12.
17. Ströckens F, Güntürkün O, Ocklenburg S. Limb preferences in non-human vertebrates. Laterality .2013;18 :536–575.
18. Carson RG. Neural pathways mediating bilateral interactions between the upper limbs. Brain Res Rev. 2005; 49: 641–662.
19. Rose DK , Winstein CJ. The co-ordination of bimanual rapid aiming movements following stroke. Clinical Rehabilitation .2005; 19: 452-462.

20. Kidgell Dawson J, Goodwill Alicia M, Frazer Ashlyn K , Daly Robin M. Induction of cortical plasticity and improved motor performance following unilateral and bilateral transcranial direct current stimulation of the primary motor cortex.BMC Neurosci. 2013; 14:64.
21. Calautti C, Baron JC. Functional neuroimaging studies of motor recovery after stroke in adults: a review. Stroke. 2003; 34:1553–1566.
22. Burgess J, Bareither R, Patton J. Single limb performance following contralateral bimanual limb training. Neural Syst Rehabilitation Eng. 2007; 15(3):347–35.
23. Stinear JW , Byblow WD . Disinhibition in the human motor cortex is enhanced by synchronous upper limb movements. J Physiol . 2002; 543: 307–316.
24. Desrosiers J, Bourbonnais D, Corriveau H, Gosselin S , Bravo G. Effectiveness of unilateral and symmetrical bilateral task training for arm during the subacute phase after stroke: a randomized controlled trial. Clin Rehabil. 2005;19:581–593.
25. Vardy AN, Daffertshofer A, Ridderikhoff A , Beek PJ . Differential after effects of bimanual activity on mirror movements. Neurosci Lett. 2007;416: 117–122.
26. Ameli M, Grefkes C, Kemper F, Riegg FP, Rehme AK, Karbe H, Fink GR, Nowak DA. "Differential effects of high-frequency repetitive transcranial magnetic stimulation over ipsilesional primary motor cortex in cortical and subcortical middle cerebral artery stroke,". Annals of Neurology.2009; 66(3): 298–309.
27. Johansen-Berg H, Dawes H, Guy C, Smith SM, Wade DT , Matthews PM. Correlation between motor improvements and altered fMRI activity after rehabilitative therapy. Brain. 2002;125:2731–2742.
28. Takeuchi N, Tada T, Toshima M, Chuma T, Matsuo Y, Ikoma K. "Inhibition of the unaffected motor cortex by 1 HZ repetitive transcranial magnetic stimulation enhances motor performance and training effect of the paretic hand in patients with chronic stroke," .Journal of Rehabilitation Medicine. 2008;40(4): 298–303.
29. Conchou F, Loubinoux I, Castel-Lacanal E , Le Tinnier Anne, Gerdelat-Mas Angélique, Faure-Marie Nathalie, Gros Helene, Thalamas Claire, Calvas Fabienne, Berry Isabelle, Chollet François , MoreauMarion Simonetta."Neural substrates of low-frequency repetitive transcranial magnetic stimulation during movement in healthy subjects and acute stroke patients. A PET study,". Human Brain Mapping.2009; 30(8): 2542–2557.
30. Rizzo V, Siebner HR, Morgante F, Mastroeni C, Girlanda P, Quartarone A. "Paired associative stimulation of left and right human motor cortex shapes interhemispheric motor inhibition based on a hebbian mechanism," .Cerebral Cortex. 2009;19(4): 907–915.
31. Grefkes C, Nowak DA, Wang LE, Dafotakis M, Eickhoff SB , Fink GR. Modulating cortical connectivity in stroke patients by rTMS assessed with fMRI and dynamic causal modeling. Neuroimage 2010; 50(1): 233–242.
32. Takeuchi N, Ikoma K. "1 Hz rTMS over unaffected hemisphere in stroke patients alters bilateral movements and coupling between motor areas,". Clinical Neurophysiology.2010; 121(1):316.
33. Di Lazzaro V, Profice P, Pilato F, Capone F, Ranieri F, Pasqualetti P, Colosimo C, Pravatà E, Cianfoni A,Dileone M ."Motor cortex plasticity predicts recovery in acute stroke," .Cerebral Cortex.2010; 20(7): 1523–1528.
34. Cunningham CL, Stoykov ME , Walter CB. Bilateral facilitation of motor control in chronic hemiplegia. Acta Psychol (Amst).2002;110:321–337.
35. Kwakkel G, Kollen BJ, Krebs HI. Effects of robot-assisted therapy on upper limb recovery after stroke: a systematic review. Neurorehabil Neural Repair .2008; 22:111-121.
36. Hesse S, Werner C, Pohl M, Rueckriem S, Mehrholz J , Lingnau ML. Computerized arm training improves the motor control of the severely affected arm after stroke: a single-blinded randomized trial in two centers. Stroke. 2005;36:1960–1966.
37. Luft AR, McCombe-Waller S, Whitall J, Forrester LW, Macko R, Sorkin JD, Schulz JB, Goldberg AP , Hanley DF. Repetitive bilateral arm training and motor cortex activation in chronic stroke: a randomized controlled trial. JAMA. 2004; 292:1853–1861.

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