Improved Function of Hemiplegic Upper Extremity after Cognitive Sensory Motor Training Therapy in Chronic Stroke Patients : Preliminary Report of a Case Series

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Abstract

Background : Recovery of upper extremity functions after a severe stroke and traumatic brain injuries (TBI) have generally been less than satisfactory. The "cognitive sensory motor training therapy" is a relatively new method claimed to improve motor control using a specific type of repetitive sensory and motor re-learning protocol. There has been no previous study demonstrating the effectiveness of this method.

Objective : To investigate the value of the cognitive sensory motor training therapy to improve upper extremity motor function in chronic stroke and TBI patients.

Material and Method : Seven patients with persistent impaired upper extremity functions for over 6 months after a stroke or TBI were trained with the cognitive sensory motor training therapy program. Hand and arm functions were measured with Action Research Arm (ARA) test before the beginning of the study and once a month thereafter. Data were analyzed retrospectively.

Results : There was improvement of ARA scores in all of the trained patients. On average there was an increase of the ARA score of 7.7 points during the average training time of 2.5 months.

Conclusion : The cognitive sensory motor training therapy may be an effective method for motor rehabilitation of chronic stroke or traumatic brain injured patients. Further prospective randomized control trials are justified and required.

Key word : Stroke, Hemiparesis, Rehabilitation, Training, Plasticity, Recovery, Hand, Arm, Action Research Arm, Upper Extremity, Therapy, Neurorehabilitation

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It is well known that poor hand and arm functional recovery causes more severe disabilities after a stroke and Traumatic Brain Injury (TBI) than equally severe impairment of lower extremity function[1]. Results of rehabilitation are frequently less than satisfactory regarding restoration of hand function. This is particularly true in the case of stroke patients with severe motor impairment[2-5]. It was generally held that there is no effective therapy to restore hand and arm function of chronic stroke patients whose arm function is still severely limited after 6 months post stroke. Even though it has been shown that repetitive task oriented training in combination with continuous restraining of the healthy arm during waking hours can improve the upper extremity function of chronic stroke patients, only those who are not too severely affected are eligible for such a training program[6-9]. There is still a tremendous need for more effective rehabilitation methods to improve hand functions in chronic patients with severely impaired upper extremity function.

Cognitive sensory motor training therapy is one of the several therapy techniques claimed to improve hand function in stroke patients[10,11]. This therapy, also known as Perfetti's method, was developed by Professor Carlo Perfetti in Italy and has become popular in several parts of Europe, especially in German, Italy, Spain and Austria. It is based on the assumption that normal control of movement is actually a cognitive process, in which the person senses and interprets kinesthetic sensation and can simultaneously select and modify the appropriate motor programs. It is believed that such a program that emphasizes primarily on training of selective attention and kinesthetic sensory perception will result in better functional outcome. Even patients who cannot actively move the limbs can "actively" participate in the training process due to it's emphasis on sensory perception tasks, especially in the early phase of training. However, there has been no previous research to verify or deny these claims.

The authors started using this technique for rehabilitation of chronic hemiplegic patients in the stroke clinic at Ramathibodi Hospital in March 2002. The aim of the present study was to investigate whether the cognitive sensory motor training therapy is of value for upper extremity motor function in chronic stroke patients.

MATERIAL AND METHOD

Subjects

Patients of the stroke rehabilitation clinic at Ramathibodi Hospital with impaired upper extremity function after a stroke or traumatic head injury over 6 months, who were able to cooperate with the training procedure and could come to follow-up evaluation and training at least once a month were included. Patients with aphasia and/or other cognitive impairments were excluded only if the patient could not adequately and actively participate in the training. Low motivation to train for improved function, inability to comply with regular home training programs (e.g. lack of caregiver support) and incomplete records of hand function evaluations were the exclusion criteria. Seven patients were included in the study. There were 6 males and 1 female patient. Their average age was 52 years old. At the time of this report five are still in the training program. The training period are between 1 to 6 months (average 2.5 months).

Training program

Details and content of the training program were carried out according to a standard text written by the originator of the technique[10]. Typically, during the early stage of training the therapist passively moved the hemiplegic arm and then asked the patient to perceive this limb position. The therapist may move the limb over training material and the patient must then try to perceive the shape of that object. Functional training such as reaching, various grips, grasp and pinch functions were taught in the later stage of the training program. An attempt was to train each patient in the out patient department for at least one or two 45-minute sessions per week. Every patient and their relatives were instructed on a home training program which was appropriate for the patient's sensory-motor ability. Two patients (patient number 1 and 5, Table 1) received only the home training program because they could not afford to come for the training sessions at the hospital. The training was continued in all patients until a plateau was reached or if patient wished to discontinue for any reasons. These patients received no therapies or training except cognitive sensory motor training therapy.

Out come measures

Hand functions were measured with Action Research Arm (ARA) test[12,13] During the test the

patients performed each of the 19 standardized tasks twice. Scores were given according to the observed performance in each task. Score 0 was given when the patient could not successfully perform even part of the task. Score 1 was for patients who could perform part of the task. For example, when a patient could pick up a test object but could not place it in the required place. Patients who performed the task, but in an abnormal movement pattern or slowly was given score 2. Score 3 was for the apparently normal movement executed. The total score was then calculated from the sum of scores obtained for each task. The lowest possible score was zero, implying total inability to use the arm for any function. Highest possible score was 57, which represented full normal hand and arm functions. This test proved to be valid and highly reliable. The ARA hand function test was done at the beginning of the training program and once every month thereafter until termination of training. Patients received no other training to improve hand functions.

RESULTS

As shown in Table 1, 5 of the patients had a stroke and 2 of them had TBI. The average duration from brain insult until beginning of cognitive sensory motor training was 12 months. There were 4 patients with left *versus* 3 patients with right hemiparesis. The training duration ranged from 1 to 6 months (average 2.5 months). The average ARA scores at pre-training and last assessment were 22.2 and 30.0 respectively. All patients showed some improvement ranging from 3 to 12 scores. The average improvement was 7.7 scores.

Scatter plots between ARA scores at the beginning of the program *versus* improvement after training, and a trend line, are shown in Fig. 1. Even though there are not enough data pairs for meaningful regression analysis, there is an observable trend suggesting that greater improvement in ARA scores after training may be associated with greater ARA scores at the beginning of training. Advances age seems not to be the major predictor of low responsiveness to therapy because the patient whose ARA score improvement was greatest happened to be the oldest in the study (76 years old, patient number 6 in Table 1).

DISCUSSION

According to the generally accepted theory, very little spontaneous recovery can be expected in

Table 1. Patients demographic, amount of training and changes of hand functional assessment scores.

Patient number	Sex	Age (years)	Diagnosis	Months after brain insult until training (months)	Side of hemiparesis	Number of total formal training sessions	ARA scores at the beginning	ARA scores after training	Improved ARA scores	Duration of training (month)	Current status
1	Male	47	Stroke : infarction	9	Lt.	0	0	3	3	2	Loss to follow-up
2	Male	39	Stroke : ICH	17	Rt.	4	12	20	8	3	Ongoing training
3	Male	54	TBI	10	Lt.	2	28	40	12	1	Ongoing training
4	Female	74	Stroke : infarction	16	Rt.	5	34	45	11	2	Ongoing training
5	Male	24	TBI	24	Rt.	0	36	40	4	1	Ongoing training
6	Male	76	Stroke : infarction	7	Lt.	14	41	52	11	6	Training discontinued, patient satisfied with "normal" hand function
7	Male	48	Stroke ; pontine infarction	13	Lt.	13	5	10	5	3	Ongoing training
Mean		52		13.7		5.4	22.2	30	7.7	2.5	
SD		19		5.8		5.8	16.3	18.8	3.7	1.7	

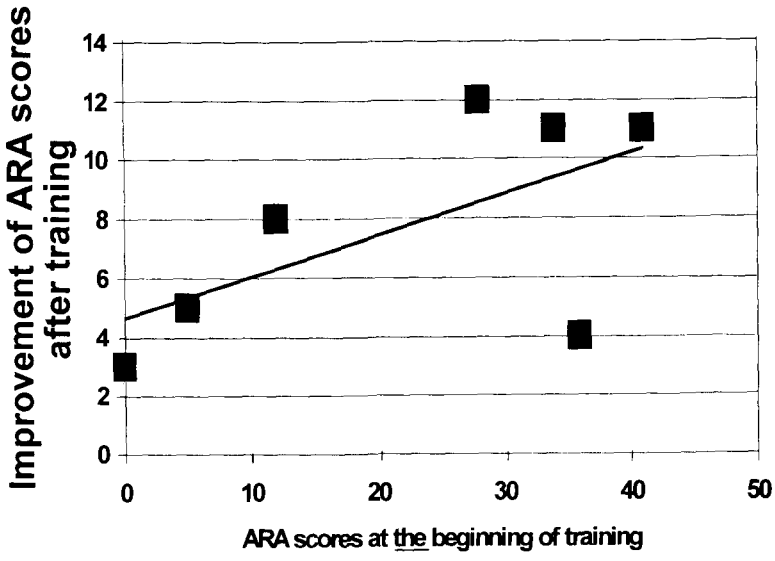

Fig. 1. Changes of ARA scores after training.

a group of chronic hemiparetic cases. So, despite the lack of a control group for comparison, positive results observed in every studied patient suggest that this form of therapy technique is effective. It is unlikely that these improvements are due to chance or measurement variation because ARA has been shown to produce very high test-re test reliability[12,13]. Patients with fewer severe motor impairments seem to benefit more but nevertheless, even those with initial ARA scores of zero also made some gain. Since the amount and frequency of therapy sessions at the hospital were quite limited in the presint study (average 5.4 sessions per patient during the average 2.5 months of training) and since many of the patients are still continuing to improve, it is possible that more intensive and extensive training may yield even greater improvements.

These positive results are compatible with those of other investigators who reported upper extremity motor function improvements after sensory discrimination training[14,15] or sensory feed back coupled with motor training[16-18]. However, these studies did not quantitatively measure the improvement of hand functions with the same assessment tool as in was used, in the present study so their results can not be compared with the presented patients. Recent longitudinal functional magnetic resonance imaging (fMRI) of patients recovering from a stroke imply that the extent of motor recovery may depend not only on the extent of damage to the primary motor cortex, but also the amount of activation of the remaining cortico-spinal connections[19,20]. This is especially true not only in the early phase of functional recovery[21], but also during control of "recovered" fine movement after a stroke such as single finger tapping[22,23]. The authors postulated that such sensory based training as used in the present study, which requires a high level of patient attention, may induce activation of the otherwise "silent" cortical neurons including their corticospinal connections and thus enable a more functional neuronal re-organization. If this is true, such techniques may induce even better recovery if applied in the sub acute stage after a stroke in which brain plasticity is known to be much greater than in the chronic stage.

Serial functional brain imaging studies and a prospective randomized clinical trial comparing functional outcomes and between chronic and/or sub acute stroke patients receiving this cognitive sensory motor training *versus* those who have undergone the standard rehabilitation program is thus justified and needed.

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REFERENCES

1. Duncan PW, Goldstein LB, Horner RD, et al. Similar motor recover of upper and lower extremities after stroke. Stroke 1994; 25: 1181-8.
2. Feys H, Hees JB, Bruyninckx F, et al. value of somator sensory and motor evoked potentials in predicting arm recovery after a stroke. J Neurol Neurosurg Psyheiatry 2000; 68: 323-31.
3. Parry RH, Linconln NB, Vass CD. Effect of severity of arm impairment on response to additional physiotherapy early after stroke. Clinical Rehabilitation 1999; 13: 187-98.
4. Fey H, DE Weerdt WJ, Selz BE, et al. Effect of a therapeutic Intervention for the hemiplegic upper limb in the acute phase after stroke: A single blind, randomized, controlled multicenter trial. Stroke 1998; 29: 785-92.
5. Duncan PW, Goldstein LB, Matchar D, et al. Measurement of motor recovery after stroke: Out come assessment and sample size requirements. Stroke 1992; 23: 1084-9.
6. Taub E, Miller N, Novack T, et al. Technique to improve chronic motor deficit after stroke. Arch Phys Med Rehabil 1993; 74: 347-54.
7. Whitall J, Waller SM, Silver KHC, et al. Repetitive bilateral arm training with rhythmic auditory cueing improves motor function in chronic hemiparetic stroke. Stroke 200; 31: 2390-5.
8. Cathereine M, Shepherd RB. Task-related training improves performance of seated reaching tasks after stroke a randomized control trial. Stroke 1997; 28: 722-8.
9. Nugent JA, Schurr KA, Adams RD. A dose-response relationship between amount of weight-bearing exercise and walking outcome following cerebrovascular accident. Arch Phys Med Rehabil 1994; 75: 399-402.
10. Perfetti C. Der aufbau der uebungen. In : Perfetti C, eds. Der hemiplegische Patient kognitive-therapeutische uebungen. 1st ed. Munich: Pflaum; 1997: 71-106.
11. Birbamer G, Beise U. Das gehirn denkt nicht in musklekontraktionen. Ars Medici 2001; 6: 282-5.
12. Lyle RC. A performance test for assessment of upper limb function in physical rehabilitation treatment and research. Int J Rehab Research 1981; 4: 483-92.
13. van der Lee JH, de Groot V, Beckerman H, et al. The intra- and interrater reliability of the action research arm test: A practical test of upper extremity function in patients with stroke. Arch Phys Med Rehabil 2001; 82: 14-9.
14. Yekutiel M, Guttman E. A controlled trial of the retraining of the sensory function of the hand in stroke patients. J Neurol Neurosurg Psychiatry 1993; 56: 241-4.
15. Carey LM, Matyas TA, Oke LE. Sensory loss in stroke patients: Effective training of tactile and proprioceptive discrimination. Arch Phys Med Rehabil 1993; 74: 602-11.
16. Hummelsheim H, Eickjof C. Repetitive sensorymotor training for arm and hand in patient with locked-in syndrome. Scand J Rehab Med 1999; 31: 250-26.
17. Buetefisch C, Hummelsheim H, Denzler P. Repetitive training of isolated movements improves the outcome of motor rehabilitation of the centrally paretic hand. J Neurol Sci 1995; 130: 59-68.
18. Carey JR, Kimberley TJ, Lewis SM, et al. Analysis of fMRI and finger tracking training in subjects with chronic stroke. Brain 2002; 125: 773-88.
19. Feydy A, Carlier R, Roby-Brami A. Longitudinal study of motor recovery after stroke : Recruitment and focusing of brain activation. Stroke 2002; 33: 1610-7.
20. Shelton F, Redling MJ. Effect of lesion location on upper limb motor recovery after stroke. Stroke 2001; 32: 107-12.
21. Mauro S, Letizia C, Fabil P. Bilateral hemispheric activation in the early recovery of motor function after stroke. Stroke 1998; 27: 1305-10.
22. Cramer SC, Nelles F, Benson RR. A functional MRI study of subjects recovered from hemiparetic stroke. Stroke 1997; 28: 2518-27.
23. Cramer SC, Nelles F, Schaechter JD. A functional MRI study of three motor tasks in the evaluation of stroke recovery. Neurorehabilitation and Neural Repair 2001; 15: 1-8.

การฟื้นฟูความสามารถการเคลื่อนไหวแขนและมือของผู้ป่วยโรคหลอดเลือดสมองและผู้ป่วยที่ได้รับการบาดเจ็บทางสมองในระยะเรื้อรังด้วยวิธีการฝึกแบบ Cognitive sensory motor training therapy : ผลการศึกษาในขั้นนำร่อง

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ศิริลักษณ์ แสงไกร, วทบ, ฉัฐยา จิตประไพ, พบ**

ที่มา : ผู้ป่วยโรคหลอดเลือดสมองและผู้ได้รับบาดเจ็บทางสมองจำนวนมากมีการฟื้นตัวของความสามารถในการเคลื่อนไหวแขนและมืออยู่ในเกณฑ์ไม่ดี โดยทั่วไปเชื่อกันว่าภายหลังจากการป่วยเกินกว่า 6 เดือนไปแล้วจะไม่มีการฟื้นคืนกลับมาเข้าสู่สภาพปรกติด้วยตนเอง (spontaneous recovery) เพิ่มขึ้นมาอีก การฝึกฝนตามแนวทาง "cognitive sensory motor training therapy" เป็นแนวทางใหม่ที่น่าสนใจและมีการกล่าวอ้างว่าอาจให้ผลในการฟื้นฟูสภาพด้านความสามารถทางการเคลื่อนไหวมือและแขนได้ดีแม้สำหรับผู้ป่วยกลุ่มดังกล่าวที่อยู่ในระยะเรื้อรัง

วัตถุประสงค์ : เพื่อประเมินผลการใช้วิธีการฝึกตามแบบของ ของ "cognitive sensory motor training therapy" เพื่อฟื้นฟูความสามาถในการเคลื่อนไหวแขนและมือของผู้ป่วยโรคหลอดลือดสมอง และผู้ป่วยภายหลังได้รับบาดเจ็บทางสมองที่มีอาการอ่อนแรงครึ่งซีกมาแล้วไม่ต่ำกว่า 6 เดือน

วิธีการวิจัย : ทำการศึกษาโดยวิเคราะห์ข้อมูลที่บันทึกไว้ของผู้ป่วยกลุ่มดังกล่าวที่มารับการฝึกด้วยวิธี "cognitive sensory motor training therapy" แบบผู้ป่วยนอกและได้เคยใช้เครื่องมือ Action Research Arm (ARA) Test ในการประเมินระดับความสามารถการเคลื่อนไหวแขนและมือเอาไว้ทั้งก่อนและหลังได้รับการฝึก

ผลการศึกษา : พบว่าผู้ป่วยทั้ง 7 รายที่ทำการศึกษามีความสามารถในการเลื่อนไหวแขนและมือดีขึ้นทุกราย โดยเฉลี่ยมีคะแนนจาก ARA test เพิ่มขึ้นถึง 7.7 คะแนน ภายในระยะเวลาการฝึกโดยเฉลี่ย 2.5 เดือนเท่านั้น

สรุป : ผลการศึกษานี้สนับสนุนว่าเทคนิคการฝึกผู้ป่วยแบบนี้น่าจะมีผลดีจริง และควรจะทำการศึกษาเพิ่มเติมอีกต่อไป

คำสำคัญ : การฟื้นฟูสภาพ, การเคลื่อนไหว, แขน, มือ, อัมพาต, สมอง

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