A Systematic Review of Efficacy of Mental Practice in Acute Stroke Rehabilitation

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ABSTRACT

Background and Purpose: *The evidence for mental practice in the treatment of movement disorders following stroke remains somewhat anecdotal. The acceptance of mental practice as an effective neuro-rehabilitation technique should depend on sound and engaging evidence. The aim of this study was to determine the effect of mental on improving functional recovery in acute phase in stroke patients.* ***Methods:*** *A systematic review of literature was conducted by the two authors, searching five electronic databases till June 2011 in addition to hand searching the bibliographies of the selected studies. The studies were selected according to specific criteria. Data were extracted according to a designed extraction sheet then studies were quality appraised by the PEDro partitioned scale.* ***Results:*** *Three randomized controlled studies were identified. The qualities of the studies were of high quality. Three different motor imagery strategies were used. Motor imagery had significant effect on trained tasks in both training and novel simulated environment as well as untrained tasks in novel simulated environment. These effects were retained and generalized. Meta-analysis could not be done because studies were not comparable.* ***Limitations:*** *Only articles published in journals and in English were included in this systematic review.* ***Conclusions:*** *Mental practice as a complement to physical rehabilitation is effective in acute stroke rehabilitation. Further studies with standardized outcome measurements and longer follow up are needed.*

Key Words: *Mental practice; motor imagery; stroke; cerebrovascular accident; motor recovery; functional recovery.*

INTRODUCTION

One of the major goals in rehabilitation for survivors of central nervous system trauma is the return to independence in activity of daily living. Fifty percent of stroke survivors present with significant limitations in activities of daily living. The success of achieving plastic changes in the central nervous system after skill training appears to be dependent on the amount of practice from that particular skill. It has been proposed that positive changes in the cortical representations at the primary sensory motor areas are activity dependent therefore stressing the importance of practice in acquisition of skill. Practice may be accomplished with overt movement i.e. actual performance of the task, or with covert movement i.e. motor imagery[1]. In an early stage of recovery, motor imagery (MI) allows patients to mentally practice a task which they cannot yet carry out physically due to motor impairment[2].

In stroke patients it is possible to keep motor circuits through the repetition of movement through motor imagination, thus facilitating and stimulating future execution of specific movements. Then when the patient achieves motor recovery or the damage is not complete and he is required to learn new abilities the use of MI associated with physical practice promotes learning through additional reinforcement processes at a subconscious level. The feedback obtained through the execution of task movements would help to produce more realistic and efficient motor images[3].

Mental practice is the voluntary rehearsal of imagery scenes or tasks, whereas motor imagery practice refers specifically to the mental rehearsal of motor imagery contents with the goal of improving motor performance[4,5]. The terms "motor imagery practice" and "mental practice" (or mental rehearsal) often are used interchangeably. Accordingly in this systematic review, these terms will be treated as synonyms[6].

It has been shown that the PEDro Scale offers a comprehensive measure of methodological quality in stroke rehabilitation literature[7]. Furthermore, in addition to the blinding component, the PEDro Scale assesses

the methodological quality of a study based on other important criteria, such as concealed allocation, intention-to-treat analysis, and adequacy of follow-up. As such, the PEDro Scale appears to be a more useful tool to assess the methodological quality of physical therapy trials[8].

Previous systematic review could not draw definite conclusions regarding effectiveness of mental practice intervention in stroke patients[4]. Other one recommended studies of better methodological quality, bigger sample size, longer follow-up and optimum time of intervention[2]. Moreover it was concluded that adding mental practice to physical practice was an effective intervention. However generalization was difficult to make. Recommendations for further studies to determine who will benefit more from training, whether improvements were retained and whether practice affects perceived occupational performance[9]. Thus in this review, the objective was to undertake a systematic review of only randomized controlled studies (RCTs) that investigated the effects of motor imagery intervention in improving the function in acute post stroke patients.

METHODS

The two authors preformed independent searches of electronic databases including science direct and springerlink, PEDro, Cochrane database, Medline / PubMed and Ovid till June 2011. In addition the authors hand searched reference lists of obtained articles. Search terms included: motor imagery, mental practice, stroke, hemiplegia, stroke, motor recovery and randomized controlled study (RCT). The search was limited to journals published in English.

Study selection

Published and completed studies were included if they had the following criteria: the patient primary diagnosis was a stroke, motor imagery/mental practice was used as treatment alone or in combination with other therapies and used to improve motor function. Level l of evidence i.e. randomized controlled trails (RCTs) was considered for this review because they are considered to have the most robust study design with least risk of biased results. The publication that appeared to meet the inclusion criteria was retrieved and full – length publication was reviewed in further detail. In a consensus meeting, the two reviewers made the final decision on whether or not a publication should be included in the final review. A third reviewer was not needed as no disagreement happened.

The methodological quality of each of included study was assessed. A standardized quality scoring form (PEDro partitioned scale) containing 10 criteria was used to assess internal validity using eight point scale [the randomization, concealed allocation, baseline similarity, blinding (patients, therapist and outcome assessor), adequacy, intention- to-treat] and statistical reporting using two point scale [between group statistical comparisons and point estimates and measures of variability]. An additional criterion (eligibility criteria) that relates to external validity was not used to calculate the PEDro score. If the available information was sufficiently clear, criteria were rated as "yes" indicating adequate method or "no" indicating inadequate method. Each "yes" was scored as 1 point and therefore a maximum of 10 points was possible. Higher score indicates higher quality [10]. PEDro scores of $\geq$4 points were classified as "high quality", whereas studies with $\leq$3 points were "low quality"[11]. This scale was found to be a reliable instrument for assessing the internal validity and statistical reporting of RCTs[12].

Data extraction

The two authors reviewed the articles that met the inclusion criteria and extracted the following data in a predesigned data extraction sheet: study, participant, intervention, Outcome measurement, dropout rate, follow up and results. Blinding of the authors was not considered feasible because both reviewers already had considerable knowledge of the literature included in the review. Any differences of opinion were resolved by discussion.

RESULTS

Three hundred and twenty articles were identified in the science direct database, springerlink (n=419), Pedro (n=13), Cochrane (n=126), Ovid (n=50), and Pubmed (n=94). Selection was based on title, abstract and key word. articles were excluded because: 1) theoretical articles; 2) participant were not primarily diagnosed as stroke[13]; 3) the intervention involved mirror therapy[14,15,16]; 4) the purpose of motor imagery was other than to improve motor recovery 4) the stage of recovery other than acute i.e. sub-acute[17,18,19] or chronic stage[20,21,22,23,24]; 5) studies other than randomized controlled studies (RCTs) or 6) combination of the above. Four studies were included[25,26,27,28]. One study by Ricoo et al.,[25] was excluded after full text reading as it recruited patients in the sub-acute stage of stroke.

The quality assessment of the three studies is summarized in table 1. In terms of internal validity, the overall scores ranged from 4 to 5. All three studies[26,27,28] were rated positively for random allocation of the groups, similar groups at baseline, key outcome measure from ≥85٪ of participants initially allocated to groups and blinding of the assessor. Conversely all studies scored negatively on blinding of participant and therapist and intention- to -treat analysis[26,27,28]. Whereas two studies scored positively on concealment of allocation[26,27]. In regard to statistical reporting, the overall scores ranged from 1 to 2 but two studies scored positively on both items[27,28].

Characteristics of included randomized controlled trails are presented in table 2. In terms of patient characteristics, all studies included participants who had sustained a unilateral right or left cerebrovascular accident. Exclusion criteria were not stated at all except in one study[27]. All studies did not assess individual participant ability to engage in imagery[26,27,28].

Concerning the intervention used, the studies combined mental and physical practice. Patients received one hour of physiotherapy for walking and strengthening exercises. Only Liu et al.,[26] mentioned that it was given at a different time of the day to minimize fatigue. Occupational therapist provided the training in MI and functional rehabilitation (FR) in two studies[26,27], while experienced stroke rehabilitation therapist administered the two programs in the third study[28].

The frequency of the intervention was the same in all three studies; 15 sessions, one hour daily on weekdays for three weeks[26,27,28]. The daily tasks used in training were clearly stated in only two studies[26,27]. The mental imagery program described by Liu et al.,[26] involved three steps: in the first week by the help of computer–generated pictures and movies the focus was on analyzing task sequences. In the second week picture cards were used to recall the steps.

Table (1): Quality Assessment of the Included Studies.

Criterion	Liu et al [26]	Liu et al [27]	Liu [28]
Internal Validity			
Random allocation	1	1	1
Concealed allocation	1	1	0
Baseline similarity	1	1	1
Blinding of participants, Therapists, and assessors	0 0 1	0 0 1	0 0 1
Measures of key outcomes from more than 85% of participants	1	1	1
Intention to treat analysis	0	0	0
Internal Validity (scored out of 8)	5/8	5/8	4/8
Statistical reporting			
Between-group statistical comparisons	1	1	1
Point measures and measures of variability	1	0	1
Statistical reporting (scored out of 2)	2/2	1/2	2/2
Eligibility criteria (not scored)	Yes	Yes	No

Table (2): Characteristics of Included Randomized Controlled Trials.

Study	Participant	Intervention	Outcome measurement, Dropout rate, Follow up and Results
Liu et al.[26]	•N=49 •22m/24f •Age (MI 71.0±6.0, FR 72.7±9.4) • Time since stroke (MI 12.3±5.3, FR 15.4±12.2	•Experimental group (MI) N=27-1 dropout - First week :analysis of task sequences via computer program; 2nd wk: problem identification via video playback; 3rd wk: task performance - OT ‘s provided the training •control group (FR) N=22 -2 dropout - demonstration –practice method was adopted of the same tasks as in MI group - OT 's provided the training All patients received: •one hour PT sessions five days a week for 3 wks for walking training and general muscle strengthening •15 sessions 1 h/ day for 3 wks •three sets of daily tasks, five tasks in each set	• 7- point Likert scale to assess task performance •CTT for cognitive abilities • 3 subtests of FM (upper and lower extremity motor function and sensation •once a pretest and once a post test after 3 wks training and one month follow up •three patients dropped out •patients in MI group reached higher level of performance on trained and untrained tasks than control group at the end of training program •at one month follow up MI group reached significantly higher level of performance than control group in both trained and untrained tasks • no significant differences in CTT and FM subscales between the groups were found
Liu et al.[27]	•N=35 •20m/13f •Age (MI 70.4±9.3, FR 69.7±7.4) • Time since stroke in days (MI 12.2±5.1, FR 12.3±7.4 • 24 lt /9 rt sided stroke	•Experimental group(MI) N=18-1 dropped out -Received one hour of MI per treatment. It involves patients truncating of task(chunking)self reflecting on their abilities deficits in performance (self regulation), feedback(using video playback, mentally rehearsing it (rehearsal) and actual performance of task •control group(FR) N=17-1 dropped out -received Received one hour of conventional occupational therapy -Involving therapist demonstration of the task then patient practicing under supervision •One hour session ,5 d per wk for 3 wks .patients trained a total of 15 daily living tasks;5 per wk •each patient received one h of daily PT(mobilization, strengthening and walking exercise) • occupational therapist provided both programs	•7- point Likert scale to assess task performance •performance of 5 trained tasks were assessed before and after three wks of training in training environment and the reassessed in novel simulated environment • performance of 3 untrained tasks were assessed in novel simulated environment • one dropped out and one excluded •no follow up •MI group had significantly higher performance scores on 4 of 5 trained tasks in the training environment while FR group had significant increase in only one task. • MI patients performed significantly better on 3 tasks than FR patients When these retested in novel simulated environment •in 3 untrained tasks MI group performed better than FR group
Liu[28]	•N=35 •21m/13f •Age (MI 70.4±9.8, FR 68.1±10.5) • Time since stroke in days (MI 12.3±5.3 , FR 12.3±7.4 • 24 lt /10 rt sided stroke	•Experimental group(MI) - N=17-1 dropped out Received one hour of MI per treatment(self reflection on abilities and deficits; mentally imaging then performing the task) •control group(FR) N=17 Received one hour of conventional occupational therapy using demonstration and practice method •training of 15 daily tasks, five tasks per week (not stated) •All patients received one hour of PT •All treatments were given five times per week for 3 wks •Experienced stroke rehabilitation therapist administrated the MI and FR program	•7- point Likert scale to assess task performance on five trained tasks in both training and novel simulated environment •Cognisat for cognitive assessment • FM (upper and lower limbs; balance; sensation; passive range of motion and joint pain •once a pretest and once a post test after 3 wks training •no follow up •one patient dropped out •significant difference between MI and FR groups in task performance score in training environment and in novel simulated environment In favour of MI group •FR group had better motor function on FM than MI group • Cognisat showed no significant difference between the groups

FM: Fugl-Meyer assessment of sensorimotor recovery. MI: mental imagery. FR: functional rehabilitation program.

In the third week, practice of the rectified task using mental imagery and actual practice. While Liu et al.,[27] used the chunking-regulation-rehearsal strategies via video playback. The MI intervention used by Liu[28] involved the patients' self reflection on their abilities and deficits that is mental imaging then actually performing the task.

All three studies assessed patients' performance on tasks using 7-point Likert scale as primary outcome measure[26,27,28]. Fifteen trained tasks and five untrained tasks including household, cooking and shopping tasks[26] while Liu et al.,[27] assessed performance on eight tasks: five trained tasks in training and novel simulated environment and three untrained tasks in novel simulated environment. Liu[28] assessed performance on five trained tasks in both training and novel simulated environment. Three subtests of Fugl-Meyer (FM) assessment of sensorimotor recovery (upper extremity and lower extremity motor function and sensation)[26] and all subtests of FM(upper extremity and lower extremity motor function, sensation, balance, passive range of motion and joint pain)[28] were used to assess motor function as primary outcome measure. The Color Trails test (CCT)[26] and the Cognistat were also assessed[28].

Three different programs of MI intervention were used. One study[26] used a computer program to guide the patients relearn the steps of performing each of the 15 tasks. A video playback was used to enhance problem identification. Mental rehearsing and actual practice were intertwined throughout the learning process. The second study involved chunking, self-regulation and rehearsal strategies[27]. In the third study, the intervention involved the patient self reflection on their abilities and deficits, mentally imaging then actually performing the task[28].

Performance of all tasks in training environment (15 trained and 5 untrained) in MI group reached significantly higher levels of performance than FR group both at the end of the training program and at one month follow up[26]. In the second study by Liu et al.,[27] the MI group outperformed the FR group in only 4 of 5 trained tasks tested in the training environment and three of five trained tasks in novel simulated environment as revealed by the significantly higher scores in task performance. Moreover only two of the three untrained tasks tested in the novel simulated environment showed significantly higher task performance. In the third study only three of five trained tested tasks had higher performance scores in the training environment. As for assessment in the novel simulated environment all five tasks had significant increase in task performance in favor of MI group after the training program[28].

DISCUSSION

This systematic review indicates that there is good evidence supporting the superimposed benefits of MI compared to only functional retraining in patients with acute stroke. The three studies included proved the positive effects of three weeks of MI intervention on enhancing task performance on the trained[26,27,28], and untrained tasks[27,28] particularly when tested in the novel environment[27,28]. Also it demonstrated a greater ability to retain the trained tasks after one month[26] and to transfer skills relearned to other untrained tasks[27,28]. On the other hand, one study revealed no effects on Fugl-Meyer (FM) assessment of sensorimotor recovery[26] and the other one had positive effects on FR group[28]. In accordance with Calayan and Dizon[1] this implies that FM is not always sensitive to the gains after imagery training in acute stroke and task specific outcome measures are needed to see these improvements.

Regarding the methodological quality of the included RCTs, it is noticeable that the methodological score (rated by the two reviewers) is of high quality. Studies are classified to three levels according to Higgins and Green (2008) as the following: 1) studies of low risk of bias which achieves the four items constituting "high quality (Adequate randomization, Allocation concealment, Prognostic similarities, and acceptable drop-out rate); 2) Studies of moderate risk of bias which achieves any or most of the four items constituting "high quality" and 3) Studies of high risk of bias which achieves none of the four items constituting low quality[29]. Two

studies are of low risk of bias[26,27] and one study is of moderate risk of bias[28].

Limitations of study

The possibility of missing some studies because of combination of search terms and terminology used in published data. Moreover studies with significant findings being more likely to be published than trails with non significant findings. Finally, limitation of search to journals published in English. The limited number of studies prevented including the articles in quantitative synthesis or meta - analysis.

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الملخص العربي

استعراض منهجي لفعالية الممارسة العقلية في تأهيل السكتة الدماغية الحادة

أجريت مراجعة منهجية من قبل المؤلفين وذلك بتفتيش خمسة قواعد للبيانات الالكترونية حتى يونيو 2011 بالاضافة إلى البحث اليدوي في فهارس الدراسات المختارة . وقد تمت الدراسات وفقا لمعايير محددة واستخراج البيانات وتقييم الجودة من خلال مقياس بيدر والمقسم . تم تحديد ثلاث دراسات عشوائيه ذات جوده عاليه . استخدمت ثلاث استيراجيات حركيه مختلفه . اظهر التخيل الحركي تأثير كبير ومعنوي على المهارات التي تم التدريب عليها في كل من بيئه التدريب وبيئه المحاكاة . اثبتت الدراسه فعاليه الممارسة العقلية كعنصر مكمل لإعادة تأهيل مرضى السكتة الدماغية الحادة . مازالت هناك حاجة إلى مزيد من الدراسات مع قياسات موحدة ومتابعة النتائج لفترات أطول .