Effects of Motor Imagery on Upper Extremity Functional Task Performance and Quality of Life among Stroke Survivors

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ABSTRACT

Purpose: *To assess the effects of Motor Imagery programme on upper extremity functional task performance and quality of life among stroke survivors.*

Method: *Thirty people who were diagnosed with stroke, were selected from the Department of Occupational Therapy, SVNIRTAR, Odisha, India, and consecutively assigned to control (n=15) and experimental (n=15) groups. The control group received conventional occupational therapy only, and the experimental group received conventional occupational therapy combined with Motor Imagery programme. Upper Extremity Motor Activity Log (UE-MAL) and Stroke Specific Quality Of Life Questionnaire (SSQOL) were used for assessment, before and after the intervention.*

Results: *The experimental group showed significant improvement compared to the control group (P<.004 & P<.001). The implication is that there is a good relationship between upper extremity functional task performance and quality of life (r= 0.928).*

Conclusions: *The Motor Imagery programme is a simple and very cost-effective treatment used in Occupational Therapy practice. It can be easily taught and learnt. The study concludes that Motor Imagery programme is effective in improving upper extremity functional task performance and quality of life among stroke survivors.*

Key words: *Motor Imagery, functional task performance, quality of life, stroke, Motor Activity Log*

INTRODUCTION

Stroke is the leading cause of adult disability. WHO defines stroke as "a focal (or at times global) neurological impairment of sudden onset, and lasting more than

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24 hours (or leading to death) and of presumed vascular origin"(Hatano, 1976). Stroke is essentially a disease of the cerebral vasculature in which a failure to supply oxygen to brain cells, which are the most susceptible to ischemic damage, leads to their death (Gillen and Burkhardt, 1998).

Surviving a stroke can be a long-term process that affects many aspects of a person's life (Lynch et al, 2008). Approximately two-thirds of stroke survivors have residual neurological deficits that persistently impair function (Whitall et al, 2000). According to a qualitative study by Harris et al (2009), more than 70% of individuals experience upper limb paresis after stroke. Participants in that study stated that use of the paretic upper limb is critical to life engagement. A strong relationship between upper limb function and ability to perform activities of daily living, social, and recreational activities has been found (Harris et al, 2009). Many stroke survivors continue to experience great difficulty in regaining functional use of their affected arms and hands (Tariah et al, 2010).

Mayo et al (2002) found that about 39% of stroke survivors still had activity limitations in self-care (bathing, dressing, grooming, feeding) and mobility, with more than 20% reporting difficulty in walking 50m and in negotiating stairs. The study also found that for higher-level activities, such as those captured by measures of Older Americans Resources and Services Instrumental Activities of Daily Living (OARS-IADL) questionnaire, only 46% had reached full independence while 54% had limitations. The most problematic activities (requiring assistance) were housework (48%), shopping (36%), travelling short distances (32%), and meal preparation (29%); less than 15% had difficulty using the telephone, handling medications, or dealing with money. In the study, the areas reported to be most problematic were travel, social activities, recreational activities, moving around the community, and having an important activity to fill the day - 36% to 41% reportedsome difficulty. Thus, the most frequent limitations and restrictions for persons with stroke can be summarised into 4 broad categories: having a meaningful activity, household tasks, travel, and basic ADL. The failure to have a meaningful activity to fill the day - be it social, recreational, or occupational -was mentioned by 53% of stroke survivors. Ability to carry out daily tasks of housework, meal preparation, and shopping was problematic for 51% of the people with stroke. Travelling any distance, whether within or outside the community, posed challenges to 50% of them. Finally, performance of even the most basic activities required for community living - bathing, walking short distances, and negotiating stairs - was an issue for 33% of the stroke survivors.

Any functional post-stroke intervention should attempt to enrich and optimise neural stimulation in order to promote brain plasticity (Holmes, 2011). Traditional rehabilitation after stroke focusses on passive (non-specific) movement or on compensatory training of the non-paretic arm(Lozano et al, 2005). Mental practice, also called symbolic rehearsal or motor rehearsal, is a training technique in which the clients repeatedly "rehearse" a motor act in working memory, without producing any overt motor output (Gaggioli et al, 2004).

Motor imagery is the mental representation of movements that involve motor planning and an internal simulation of motor activity (Sabate et al, 2004). It is a complex cognitive operation that is self-generated using sensory and perceptual processes, enabling the reactivation of specific motor actions within working memory. There is abundant evidence of the positive effects of motor imagery practice on motor performance and learning in athletes, people who are healthy, and people with neurological conditions (e.g., stroke, spinal cord injury, Parkinson disease) (Dickstein and Deutsch, 2007).

During mental practice for example, while the subjects observed hand movements, activation was principally in the visual cortex areas, as well as in areas involved in motor behaviour (e.g., basal ganglia and cerebellum) (Decety and Jeannerod, 1996). When they imagined moving their own hands, cortical and sub-cortical areas involved in motor preparation and programming were active (Carr and Shepherd, 1998). Changes to cortical motor output maps show that mental practice alone can lead to the plastic changes in motor system (Pascual-Leone et al, 1995).

Gaggioli et al (2006) suggest that computer-supported mental training is a feasible and potentially effective approach for improving motor skills after stroke. Ewan et al (2010) found that an observation-based intervention has positive effects in stroke rehabilitation. Riccioet al (2010) found that mental practice is effective in upper limb recovery after stroke. Page (2000) believes that Imagery improves upper extremity motor function in chronic stroke survivors. Liu et al (2004a, 2004b) found that mental imagery is effective in ADL tasks (such as household tasks, cooking, shopping) among acute stroke survivors.

Stroke disability and morbidity lead to reduced quality of life (QOL) among stroke survivors Three months after the stroke their quality of life was low,andshowed no improvement during the follow-up year (Jaraczand Kozubski, 2003; Nichols-Larsen et al, 2005; Keh-chung Lin et al, 2011). Stroke affects various dimensions of quality of life and the most important determinants that were impaired were

Physical functioning, Physical role limitations, Vitality and General health (Kauhanen, 2000).

Lynchet al (2008) stated that clients and caregivers tended to perceive QOL to be deeply affected by role changes. Role changes were also related to issues of dependence and social support. Social roles altered radically when clients could no longer work. One of the issues most frequently raised by stroke survivors was the maintenance of critical social relationships. Stroke puts severe stress on social relationships and, according to the survivors, often results in break-ups with significant others, for example, spouses or children. These relationship changes have a deep impact on both clients and caregivers. However, in contrast to clients, caregivers were more likely to mention ways in which the stroke strengthened client relationships with significant others (i.e., spouses or children).

Functional recovery of the paretic upper extremity, post-stroke, continues to be one of the greatest challenges faced by rehabilitation professionals (Dowarah, 2013). Although most clients regain walking ability, only 5% of adults regain full arm function after stroke, and 20% do not regain any functional use (Whitall et al, 2000). Hence, alternative strategies are needed to reduce long-term disability and functional impairment caused by stroke.

A systemic review of literature, by searching databases from 1985 up to February 2009 and selecting studies according to specified criteria, rated each study for level of evidence and summarised study elements, concluding that when added to physical practice, mental practice is an effective intervention (Dawn et al, 2010).

Objective

This study focusses on upper extremity functional task performance and quality of life and its relationship, using Motor Imagery programme.

Alternate Hypothesis

1. There is a significant difference in upper extremity functional task performance and quality of life using Motor Imagery in stroke survivors.
2. There is a significant relationship between upper extremity functional task performance and quality of life.

Null Hypothesis

1. There is no significant difference in upper extremity functional task performance and quality of life using Motor Imagery in stroke survivors.
2. There is no significant relationship between upper extremity functional task performance and quality of life.

METHOD

Study Design

A pre- and post-experimental design was used.

Subjects and Settings

30 stroke survivors who fulfilled the inclusion criteria were selected for the study from SVNIRTAR's Department of Occupational Therapy.

The inclusion criteria were:

- Subjects diagnosed with stroke;
- Unilateral CVA, due to haemorrhage and infarction of either hemisphere;
- Both males and females;
- Age between 30 and 80 years;
- Score 56 or less on the Movement Imagery questionnaire;
- No perceptual, cognitive deficits (MMSE >24).

The exclusion criteria were:

- Upper limb musculoskeletal or neurological condition other than stroke;
- Head injury leading to hemiplegia;
- Receptive aphasia;
- Visual impairments.

Screening Tools

- **Mini-Mental Status Examination (MMSE)**

The Mini-Mental Status Examination (MMSE) offers a quick and simple way to quantify cognitive function and screen for cognitive loss. It tests the individual's orientation, attention, calculation, recall, language and motor skills. The MMSE has been extensively studied and shows excellent reliability. Validity appears good. The individual can obtain a maximum score of 30 points. A score below 20 usually indicates cognitive impairment(Kurlowicz et al, 1999).

- **Movement Imagery Questionnaire-Revised (MIQ-RS)**

This self-reporting psychological questionnaire is used to assess visual and kinaesthetic movement imagery ability. The first involves the attempt to form a visual image or picture of a movement in one's mind. The second is the attempt to feel what performing a movement is like, without actually doing it. In this questionnaire, subjects are requested to do both these mental tasks for a variety of movements, and then rate how easy/difficult they found the tasks to be(Gregg et al, 2010).

Outcome Measures

- **Upper Extremity Motor Activity Log (UE-MAL)**

This instrument is a structured interview intended to examine how much and how well the subjects use their more-affected arm outside of the laboratory setting. A 6-point Amount of Use (AOU) scale rates how much the client used his/her affected arm, and a 6-point Quality of Movement (QOM) scale rates how well he/she used it. The reliability is .99 and .96 (Uswatte et al, 2006).

- **Stroke Specific Quality Of Life (SS-QOL)**

This consists of 12 domains on quality of life. These domains include Energy(3 questions), Family roles (3), Languages (5), Mobility (6), Mood (5), Personality (3), Self-care (5), Social roles (5), Thinking (3), Upper Extremity function (5), Vision (3), and Work/Productivity (3). The tool consists of 49 items. The maximum score is 249 and the minimum score is 49.The scores which fall between 49 and 123 are said to indicate poor quality of life, and the scores which fall between 124 and 249 indicate good quality of life (Williams et al, 1999).

Procedure

After screening, clients who met the inclusion criteria were consecutively assigned to control and experimental groups respectively. Informed consent was obtained from them. Upper Extremity Motor Activity Log and Stroke Specific Quality Of Life Questionnaire were administered. After the pretest, therapy was begun.

The control group received conventional occupational therapy only, while the experimental group received conventional occupational therapy combined with Motor Imagery programme.

The Motor Imagery programme consists of the following activities:

- 8 minutes of listening to a tape-recording of relaxation techniques (2minutes of deep breathing exercise and 6 minutes of progressive muscular relaxation).
- 20 minutes of exercises related to motor imagery. In the first week, the Motor Imagery training involves using computer images and movies to analyse steps and sequences required to successfully complete a task, i.e., reaching for a cup or turning a page in a book.
- In the second week, clients are trained to identify problems they have with the tasks and to correct them using motor imagery.
- In the third week, they practise the corrected tasks mentally as well as perform the actual tasks.
- The session concludes with the individuals being given time to refocus on the room they are in.

After 3 weeks, post-test scores were taken for both groups.

Data Analysis

The Test parameters were compared before and after therapy. Statistical calculations were performed with SPSS version 16.0 package. Statistical tests were carried out with the level of significance set at $p \leq 0.05$.

The raw scores of pre- and post-intervention of both the outcome measures (Motor Activity Logand Stroke Specific Quality of Life) were added and summed up into final scores. Since it was a small sample size, the author used non-parametric statistics. As this was a 2-tailed non- parametric study, the changes in both the outcome measures within control and experimental groups were analysed using Wilcoxon Sign Ranks Test. Mann–Whitney U Test was performed to know the significance of differences between the groups. Spearman Rank Correlation test was used to analyse the relationship between upper extremity functional task performance and quality of life.

RESULTS

The individual characteristics of the control and experimental groups are given in Table 1.

Table 1: Descriptive Characteristics

S.No.	Baseline Characteristics	Group A (Control)	Group B (Experimental)
1.	No. of subjects	15	15
2.	Age range (years)	34-77	34-68
3.	Mean age (±Std Dev.)	53.2(±12.4)	51.933(±10.4)
4.	Gender (M/F)	13/2	12/3
5	Right / Left hemiplegia	9/6	10/5

Table 2: Descriptive Statistics of Outcome Measures

OUTCOME MEASURE	Mean test score (Group A) CONTROL (N = 15)		Mean test score (Group B) EXP (N = 15)	
	Pre-test	Post-test	Pre-test	Post-test
UE MAL	3.10	3.83	3.24	5.89
SSQOL	111.53	131	118.33	161

Table 3: Results of Wilcoxon Sign Rank Test for Upper Extremity Motor Activity Log scale within the groups

GROUPS	Mean Diff.	z	p (2-tailed)
CONTROL	0.73	-3.41	0.001 *
EXPERIMENTAL	2.65	-3.40	0.001*

* Level of Significance

The results show that there is a significant improvement in the control and experimental groups with 'p' values of 0.001 and 0.001 respectively.

Table 4: Results of Wilcoxon Sign Rank Test for Stroke Specific Quality of Life scale within the groups

GROUPS	Mean Diff.	z	p (2-tailed)
CONTROL	19.47	-3.409	0.001 *
EXPERIMENTAL	43	-3.408	0.001 *

* Level of Significance

The results of this Table show there issignificant improvement in Quality of Life in the control and experimental groups, with 'p' values of 0.001 and 0.001 respectively.

Table 5: Results of Mann-Whitney U test between the groups

OUTCOME MEASURES	Mean Diff.	z value	p value
UE MAL	2.06	- 2.800	0.004 *
SS-QOL	30	- 3.389	< 0.001*

*Level of Significance

The experimental group shows higher scores than the control group in both the outcome measures, but it was statistically significant as shown by results of Mann-Whitney U test at the 'p' values of 0.004 and < 0.001 respectively.

Table 6: Spearman Rank Correlation tests results for the relationship between Upper Extremity Functional Task performance and Quality of Life

Group	Spearman Rank Correlation (r)	Level of significance (2-tailed)
CONTROL GROUP	0.723	0.002*
EXPERIMENTAL GROUP	0.928	<0.001*

* Level of Significance

Both the groups show the good relationship between upper extremity functional task performance and quality of life.

DISCUSSION

This study was designed to examine the effects of Motor Imagery on upper extremity functional task performance and quality of life among stroke survivors. The study suggests that Motor Imagery along with conventional occupational therapy can improve upper extremity functional task performance and quality of life, and there is a good relationship between upper extremity functional task performance and quality of life.

Effect on Upper Extremity Functional Task performance

In this study, ordinary daily life activities were chosen because functional tasks would be applicable to all clients. Computer images and videos of daily activities were shown and clients were trained to analyse the steps and sequences involved in the execution of the tasks. If they made mistakes, they were trained to identify their problems. Attaining the ability to perform the task would directly result in improvement to their daily lives. The level of complexity of the task was increased according to the improvement in upper extremity function. On statistical analysis, the mean values of Motor Activity Log scale post-scores were 3.833 and 5.89 respectively. The values were determined to be significant at 0.004 levels (Table 5), which supports the alternate hypothesis suggesting that motor imagery programme improves upper extremity functional task performance among stroke survivors.The findings of this study are consistent with previous motor imagery studies on rehabilitation of stroke survivors by Stevens and Stoykov(2003) and Page et al (2001a, 2001b).

Several theories can be found in the literature to support the use of motor imagery in improving functional tasks. Symbolic learning theory, which proposes that mental practice facilitates motor performance by allowing the individual to rehearse the cognitive components of a task, fits well in the current study(Amasiatu, 2013). Psycho-neuromuscular theory proposes that imagery activates the neural pathways involved in the task just like physical practice providing extra practice (Jackson et al, 2001; Page et al,2001a, 2001b). It is also established that individuals with stroke retain the ability to mentally represent activities they can no longer perform physically (Johnson et al,2002).

Jackson et al (2001) and Kosslyn et al (2001) demonstrated substantial physical changes in strength via imagined actions and the suggested that motor imagery might act to improve function in the motor system due to the fact that motor pathways are generally activated during motor imagery.

In the current study, prior to the intervention all the clients were not in the habit of using their affected arms for functional tasks. They exhibited difficulty in extending their wrists and in using their fingers for tasks like writing. Post-intervention, both the groups showed improvements in Motor Activity Log scale, but the motor imagery group showed significantly more improvement in functional tasks. In both the groups, no improvement was noticed in tasks such as putting on and taking off socks and shoes. This could be attributed to cultural variables since the clients, coming from village areas and with low socio-economic backgrounds, were probably unused to wearing shoes and socks.

Effect on Quality Of Life

The mean values of stroke-specific quality of life scale post-scores of control and experimental groups were 131 and 161 respectively. On statistical analysis, the values were determined to be significant at $p<0.001$ levels (Table 5), which supports the alternate hypothesis suggesting that motor imagery programme improves quality of life among stroke survivors.

In SSQOL, the area of self-care, work/productivity and upper-extremity function domains are closely related to functional performance. The level of disability has repeatedly been found to correlate withdiminished QOL in the area of physical functioning (Nicholas-Larsen , 2005).

The study by Verbunt et al (2008) found that mental practice-based rehabilitation training improves quality of life among stroke clients. Dettmers et al (2005) found that distributed CIMT is a promising intervention for improving motor function and QOL in chronic strokeclients.

Relationship between Upper Extremity Functional Task performance and Quality of Life

In this study, a positive relationship has been found between upper extremity functional task performance and quality of life. The Spearman correlation coefficientin control group was r= 0.723, and in the experimental group r=0.928. On statistical analysis, the values were determined to be significant at 0.002 and 0.001 levels (Table 6), which supports the alternate hypothesis. It indicates there is a good relationship between upper extremity functional task performance and quality of life.

To date, there has been no study to find the correlation between upper extremity functional task performance and quality of life. A few studies (Nakayama et al, 1994; Mandal and Mokashi, 2009) correlated recovery of upper extremity motor function and Activities of Daily Living among stroke survivors, and concluded that there is a positive relationship between the two.

Motor Imagery can easily be taught and learnt. It can be of particular benefit to stroke clients and those who are easily fatigued. Since motor imagery involves the integration of the body and mind for performing tasks, it is a core concept of Occupational Therapy (Jarus and Ratzon, 2000) and should be considered an important and very effective method in Occupational Therapy practice.

However, there can also be difficulties in incorporating motor imagery into clinical practice as the clients may consider it to be too simple and may not be willing to try it.

CONCLUSION

Motor Imagery can be used effectively in clinical practice to treat stroke clients. It provides an easy way to re-learn motor tasks with less exertion, a point that may be critical for the population with stroke.

This study concluded that Motor Imagery programme is effective in improving upper extremity functional task performance and quality of life among stroke survivors. It has also found strong evidence of a positive relationship between upper extremity functional task performance and quality of life.

Limitations and Recommendations

- The sample size was small (only 30), hence studies including larger groups are recommended.
- Follow-up on retention of the effects of motor imagery was not done. Future studies on the follow-up effects are recommended.
- Further study to compare the effects of motor imagery among males, as opposed to females, is recommended.
- The duration of the study was short. Studies of longer duration are recommended.

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REFERENCES

Amasiatu A (2013). Mental imagery rehearsal as a psychological technique to enhancing sports performance. Educational Research International; 1(2): 69-77. Available from: http://www.erint.savap.org.pk/PDF/Vol.1(2)/ERInt.2013(1.2-07).pdf

Bovend'Eerdt TJ, Dawes H, Sackley C, Hooshang I, Wade DT (2010). An integrated motor imagery programme to improve functional task performance in neurorehabilitation: A single-blind randomised controlled trial. Arch Phys Med Rehabilitation; 91: 939-946. http://dx.doi.org/10.1016/j.apmr.2010.03.008 PMid:20510987

Butler AJ, Page SJ (2006). Mental practice with motor imagery: Evidence for motor recovery and cortical reorganisation after stroke. Archives of Physical Medicine & Rehabilitation; 87(12 Suppl 2): S2-11. http://dx.doi.org/10.1016/j.apmr.2006.08.326 PMid:17140874 PMCid:PMC2561070

Carr JH, Shepherd RB (1998). Neurological rehabilitation: Optimising motor performance. Butterworth-Heinemann Publications.

Dawn MN, Glen G, Andrew MG (2010). Use of mental practice to improve upper-limb recovery after stroke: A systematic review. American Journal of Occupational Therapy; 64: 695-708. http://dx.doi.org/10.5014/ajot.2010.09034

Decety J, Jeannerod M (1996). Mentally simulated movements in virtual reality: Does Fitts's law hold in motor imagery?. Behavioural Brain Research; 72: 127–134. http://dx.doi.org/10.1016/0166-4328(96)00141-6

Dettmers C, Teske U, Hamzei F, Uswatte G, Taub E, Weiller C (2005). Distributed form of constraint-induced movement therapy improves functional outcome and quality of life after stroke. Archives of Physical Medicine and Rehabilitation; 86(2): 204-209. http://dx.doi.org/10.1016/j.apmr.2004.05.007 PMid:15706544

Dickstein R, Dunsky A, Marcovitz E (2005). Motor imagery for gait rehabilitation in post-stroke hemiparesis. Physical Therapy; 84(12): 1167-1175.

Dickstein R, Deutsch JE (2007). Motor imagery in physical therapist practice. American Physical Therapy Association; 942-953. http://dx.doi.org/10.2522/ptj.20060331

Dijkerman HC (2004). Does motor imagery training improve hand function in chronic stroke patients? A pilot study. Clinical Rehabilitation; 18(5): 538-49. http://dx.doi.org/10.1191/0269215504cr769oa PMid:15293488

Dowaraha BP (2013). The effects of BIT versus MCMIT on functional performance in upper extremity in chronic hemiparesis. Scientific Research Journal of India; 2(4).

Ertelt D, Small S, Solodkin A, Dettmers C, McNamara A, Binkofski F, Buccino G (2007). Action observation has a positive impact on rehabilitation of motor deficits after stroke. Neuroimage; 36: 164-173. http://dx.doi.org/10.1016/j.neuroimage.2007.03.043 PMid:17499164

Ewan LM, Kathryn K, Holmes P (2010). An observation-based intervention for stroke rehabilitation: Experiences of eight individuals affected by stroke. Disability and Rehabilitation; 32(25): 2097-210. http://dx.doi.org/10.3109/09638288.2010.481345 PMid:20455707

Gaggioli A, Morganti F, Walker R, Meneghini A, Alcaniz M, Lozano J A, Montesa J A, Gil J A, Riva G (2004). Training with computer-supported motor imagery in post-stroke rehabilitation. Cyberpsychology & Behaviour; 7(3): 327-332. http://dx.doi.org/10.1089/1094931041291312 PMid:15257833

Gaggioli A, Meneghini A, Morganti F, Alcaniz M, Riva G (2006). A strategy for computer-assisted mental practice in stroke rehabilitation. Neurorehabil Neural Repair; 20: 503. http://dx.doi.org/10.1177/1545968306290224 PMid:17082506

Gillen G, Burkhardt A (1998). Stroke rehabilitation: A function based approach. New York; Mosby Publication: 125.

Gregg M, Hall C, Butler A (2010). The MIQ-RS: A suitable option for examining movement imagery ability. Evidence-Based Complementary and Alternative Medicine; 7(2): 249-257. http://dx.doi.org/10.1093/ecam/nem170 PMid:18955294 PMCid:PMC2862926

Haan RJ, Limburg M, Meulen JH, Jacobs HM, Aaronson NK (1995). Quality of life after stroke: Impact of stroke type and lesion location. Stroke; 26(3): 402-408. http://dx.doi.org/10.1161/01.STR.26.3.402 PMid:7886714

Harris JE, Eng JJ, Miller WC, Dawson AS (2009). A self-administered graded repetitive arm supplementary programme (GRASP) improves arm function during in-patient stroke rehabilitation. A multi-site randomised controlled trial. Stroke; 40(6): 2123-2128. http://dx.doi.org/10.1161/STROKEAHA.108.544585 PMid:19359633

Hatano S (1976). Experience from a multicentre stroke register: a preliminary report. Bulletin of the World Health Organisation; 54(5): 541-553. PMid:1088404 PMCid:PMC2366492

Holmes PS (2007). Theoretical and practical problems for imagery in stroke rehabilitation: an observation solution. Rehabil Psychology; 52(1): 1–10. http://dx.doi.org/10.1037/0090-5550.52.1.1

Holmes P (2011). Evidence from cognitive neuroscience supports action observation as part of an integrated approach to stroke rehabilitation. Manual Therapy; 16(1): 40-41. http://dx.doi.org/10.1016/j.math.2010.06.011 PMid:20674463

Jackson PL, Lafleur MF, Malouin F, Richards C, Doyon J (2001). Potential role of mental practice using motor imagery in neurologic rehabilitation. Archives of Physical Medicine Rehabilitation; 82(8): 1133-41. http://dx.doi.org/10.1053/apmr.2001.24286 PMid:11494195

Jaracz K, Kozubski W (2003). Quality of life in stroke patients. Acta Neurol Scand; 107(5): 324–329. http://dx.doi.org/10.1034/j.1600-0404.2003.02078.x PMid:12713523

Jarus T, Ratzon N Z (2000). Can you imagine? The effect of mental practice on the acquisition and retention of a motor skill as a function of age. Occupational Therapy Journal of Research; 20(3): 163-178.

Jeannerod M (2001). Neural simulation of action: a unifying mechanism for motor cognition. NeuroImage; 14: S103–S109. http://dx.doi.org/10.1006/nimg.2001.0832 PMid:11373140

Johnson SH, Sprehn G, Saykin AJ (2002). Intact motor imagery in chronic upper limb hemiplegics: evidence for activity independent action representations. Journal of Cognitive Neuroscience; 14(6): 841-852. http://dx.doi.org/10.1162/089892902760191072 PMid:12191452

Kauhanen M (2000). Quality of life after stroke: clinical, functional, psychosocial, and cognitive correlates. Oulu university Library.

Keh-chung Lin, Tiffany Fu, Ching-yi Wu, Ching-ju H (2011). Assessing the stroke-specific quality of life for outcome measurement in stroke rehabilitation: minimal detectable change and clinically important difference. Health and Quality of Life Outcomes; 9:5. http://dx.doi.org/10.1186/1477-7525-9-5 PMid:21247433 PMCid:PMC3034658

King RB (1996). Quality of life after stroke. Stroke; 27: 1467-1472 http://dx.doi.org/10.1161/01.STR.27.9.1467 PMid:8784114

Kosslyn SM, Ganis G, Thompson WL (2001). Neural foundations of imagery. Nat Rev Neuroscience; 2(9): 635-642. http://dx.doi.org/10.1038/35090055 PMid:11533731

Kurlowicz L, Wallace M (1999). The Mini Mental State Examination (MMSE). Issue Number 3. The Hartford Institute For Geriatric Nursing, Division Of Nursing, New York University. http://dx.doi.org/10.3928/0098-9134-19990501-08

Lozano JA, Montesa J, Juan MC, Alca-iz M, Rey B, Gil J, Martinez JM, Gaggioli A, Morganti F (2005). VR-Mirror: a virtual reality system for mental practice in post-stroke rehabilitation. Lecture Notes in Computer Science; 3638: 241-251. http://dx.doi.org/10.1007/11536482_23

Liu KP, Chan CC, Lee TM, Hui-Chan CW (2004a). Mental imagery for promoting relearning for people after stroke: a randomised controlled trial. Archives of Physical Medicine and Rehabilitation; 85(9): 1403-1408. http://dx.doi.org/10.1016/j.apmr.2003.12.035 PMid:15375808

Liu KP, Chan CC, Lee TM, Hui-Chan CW (2004b). Mental imagery for relearning of people after brain injury. Brain Injury; 18(11): 1163-72. http://dx.doi.org/10.1080/02699050410001671883 PMid:15545212

Lynch EB, Butt Z, Allen H, David V, Cindy J N, Lori P (2008). A qualitative study of quality of life after stroke: the importance of social relationships. Journal of Rehabilitation Medicine; 40: 518–523. http://dx.doi.org/10.2340/16501977-0203 PMid:18758667 PMCid:PMC3869390

Mandal AK, Mokashi SP (2009). Effect of occupational therapy task-oriented approach on recovery of upper extremity motor function and activities of daily living in stroke patients. Indian Journal of Occupational Therapy; XLI(2): 31-36.

Mayo NE, Wood-Dauphinee S, Durcan L, Carlton J (2002) Activity, participation, and quality of life 6 months post stroke. Archives Physical Medical Rehabilitation; 83: 1035- 42. http://dx.doi.org/10.1053/apmr.2002.33984

Nakayma H, Jorgensen HS, Raaschou HU, Olsen TS (1994). Compensation in recovery of upper extremity function after stroke: the Copenhagen stroke study. Archives Physical Medical Rehabilitation; 75: 852-857. http://dx.doi.org/10.1016/0003-9993(94)90108-2

Nichols-LarsenDS, Clark PC, Zeringue A, Greenspan A, Blanton S (2005). Factors influencing stroke survivors' quality of life during subacute recovery. Stroke; 36: 1480-1484. http://dx.doi.org/10.1161/01.STR.0000170706.13595.4f PMid:15947263

Page SJ (2000). Imagery improves upper extremity motor function in chronic stroke patients: a pilot study. The Occupational Therapy Journal of Research; 20(3): 200-213. http://dx.doi.org/10.1177/153944920002000304

Page SJ, Levine P, Leonard AC (2005). Effects of mental practice on affected limb use and function in chronic stroke. Archives Physical Medical Rehabilitation; 86: 399-402. http://dx.doi.org/10.1016/j.apmr.2004.10.002 PMid:15759218

Page SJ, Levine P, Sisto S, Johnston MV (2001a). A randomised efficacy and feasibility study of imagery in acute stroke. Clinical Rehabilitation; 15: 233-240. http://dx.doi.org/10.1191/026921501672063235 PMid:11386392

Page SJ, Levine P, Sisto S, Johnston MV (2001b). Mental practice combined with physical practice for upper-limb motor deficit in sub-acute stroke. Physical Therapy; 81(8): 1455-1462. PMid:11509075

Page SJ, Laine D, Leonard AC (2007). Mental practice in chronic stroke: results of a randomised, placebo-controlled trial. Stroke; 38(4): 1293-7. http://dx.doi.org/10.1161/01.STR.0000260205.67348.2b PMid:17332444

Pascual-Leone A, Nguyet D, Cohen LG, Brasil-Neto JP, Cammarota A, Hallett M (1995). Modulation of muscle responses evoked by transcranial magnetic stimulation during the acquisition of new fine motor skills. J Neurophysiol; 74(3): 1037-45. PMid:7500130

Riccio I, Iolascon G, Barillari MR, Gimigliano R, Gimigliano F (2010). Mental practice is effective in upper limb recovery after stroke: a randomised single-blind cross-over study. Eur J Phys Rehabil Med; 46(1): 19-25. PMid:20332722

Sabate M, Gonzalez B, Rodriguez M (2004). Brain lateralisation of motor imagery: motor planning symmetry as a cause of movement lateralisation. Neuropsychologia; 42(8): 1041-1049. http://dx.doi.org/10.1016/j.neuropsychologia.2003.12.015 PMid:15093143

Stevens JA, Stoykov PME (2003). Using motor imagery in the rehabilitation of hemiparesis. Archives of Physical Medicine & Rehabilitation; 84(7): 1090-1092. http://dx.doi.org/10.1016/S0003-9993(03)00042-X

Tariah HA, Almalty A, Sbeih Z and Al-Oraibi S) 2010). Constraint induced movement therapy for stroke survivors in Jordon: a home-based mode. International Journal of Therapy and Rehabilitation; 17: 638–646. http://dx.doi.org/10.12968/ijtr.2010.17.12.638

Uswatte G, Taub E, Morris D, Light K, Thompson PA (2006). The Motor Activity Log - 28: assessing daily use of the hemiparetic arm after stroke. Neurology; 67: 1189-1194. http://dx.doi.org/10.1212/01.wnl.0000238164.90657.c2 PMid:17030751.

Verbunt JA, Seelen HAM, Ramos FB, Michielsen B, Wetzelaer W, Moennekens (2008). Mental practice-based rehabilitation training to improve arm function and daily activity performance in stroke patients: a randomised clinical trial. BMC Neurology; 8: 7 http://dx.doi.org/10.1186/1471-2377-8-7 PMid:18405377 PMCid:PMC2329664.

Whitall J, Waller SM, Silver K, Macko R (2000). Repetitive bilateral arm training with rhythmic auditory cueing improves motor function in chronic hemiparetic stroke. Stroke; 2390-239. http://dx.doi.org/10.1161/01.STR.31.10.2390.

Williams L, Weinberger M, Harris LE, Clark D, Biller J (1999). Development of a stroke-specific quality of life scale. Stroke; 30: 1362-1369. http://dx.doi.org/10.1161/01.STR.30.7.1362 PMid:10390308.