

The influence of mirror therapy on functional limitations of hemiparetic patients: a systematic review

Lívia Portugal da Conceição¹, Priscila de Souza², Leyne de Andrade Cardoso³

ABSTRACT

The purpose of this study was to assess the influence of mirror therapy (MT) on sensory and motor deficits of hemiparetic patients affected by stroke, through systematic review. **Method:** A review was performed in the LILACS, MEDLINE, PubMed and SciELO databases, covering the last 12 years. The classification of articles was made through the PEDro platform. **Results:** This study included all five articles, clinical trials, and randomized controlled trial, which used MT in the treatment of hemiparetic patients. The scores of studies ranged from 4 to 7 by the PEDro scale, with an average grade of 6.2. **Discussion:** Some studies have shown that MT is beneficial to increase the accuracy, range, and speed of movement and other studies have indicated that there is a greater recovery and motor function in patients treated with MT. One study analyzed hemiparetic patients with acute stroke and with complex regional pain syndrome type 1 (CRPSt1), concluding that MT improves motor and sensory function. **Conclusion:** MT is beneficial for motor recovery, sensory-motor function, and decreased pain. Individuals affected by stroke require physical therapy and the amount of therapy can influence the motor learning and neural plasticity. We know the importance of intensive stimulation to increase the adaptive capacity of the central nervous system in response to experiences, and adaptations to repeated stimuli under various conditions. Thus, it is necessary to carry out new clinical protocols with different frequencies to show future results with reality in rehabilitation centers.

Keywords: exercise therapy, motor skills, rehabilitation, stroke

¹ Physical Therapist at the Instituto de Medicina Física e Reabilitação do Hospital das Clínicas da Faculdade de Medicina da USP / Centro de Reabilitação Umarizal (Physical Medicine and Rehabilitation Institute at the Clinics Hospital, Medical School of the University of São Paulo - HC FMUSP / Umarizal Rehabilitation Center).

² Physical Therapist at the Physical Medicine and Rehabilitation Institute at the Clinics Hospital, Medical School of the University of São Paulo - HC FMUSP / Umarizal Rehabilitation Center.

³ Physical Therapist at the Physical Medicine and Rehabilitation Institute at the Clinics Hospital, Medical School of the University of São Paulo - HC FMUSP / Umarizal Rehabilitation Center.

Mailing address:

Instituto de Medicina Física e Reabilitação
HC FMUSP/Centro de Reabilitação Umarizal
Guaramembé, 589
São Paulo - SP
CEP 05754-060

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INTRODUCTION

According to the World Health Organization (WHO),¹ cerebrovascular diseases are the second leading cause of death worldwide. Among these are strokes, defined as acute events of vascular origin lasting more than 24 hours that cause neurological impairment.² A stroke can be caused either by the obstruction or rupture of a cerebral artery, respectively called ischemic or hemorrhagic.³ The consequences can be varied, including cognitive, perceptual, linguistic, or motor impairment, which bring functional limitations to those afflicted.⁴⁻⁶ Cognitive after-effects include attention and memory loss.⁷⁻⁹ Sensory alterations correspond to loss of surface sensitivity (tactile, thermal, and pain), proprioceptive (motor, postural, and balance control), and visual (homonymous hemianopsia).⁹ Sensory alterations are considered among those most responsible for limiting the functional motor recovery of stroke patients, being more serious in patients with the left hemibody affected (right hemisphere impaired).³ Language alterations include aphasias, identified in 40% of stroke cases, which could be either in expression (motor) or comprehension (sensory), or a mixture.^{9,10} One of the most frequent motor impairments is hemiparesis, characterized by weakness in the hemibody contralateral to the impaired brain hemisphere, seen in an average of 60% of the cases.¹¹

There are various types of functional evaluations, as well as the Functional Independence Measurement (c),¹² which is validated for the Portuguese language, the Modified Ashworth Scale (MAS), the Visual Analog Scale (VAS), the Brunnstrom, and others.

Owing to the variability of stroke sequelae, there are various types of physiotherapeutic treatment, as well as: Neuromuscular Electrical Stimulation,¹³ muscular strengthening,¹⁴ the Bobath neurodevelopment treatment,¹⁵ constraint-induced movement therapy,¹⁶ neuro-proprioceptive facilitation,¹⁷ and the therapy of interest in this review: mirror exercise therapy.¹⁸

Mirror exercise therapy was described for the first time with amputees by Ramchandram et al.¹⁸ The mirror was placed in the sagittal plane of the individual and reflected the healthy arm as if it were the impaired limb. The visual feedback induced by the mirror helped in organizing the perceptual and visual stimuli, and in possibly

reorganizing the central nervous system, and also in the plasticity of the pre-motor cortex, which can also help interrupt the pain cycle improving muscle strength and functional independence.¹⁹

Therefore, what would be some benefits to a protocol that used mirror exercise therapy as a way of treating stroke patients?

OBJECTIVE

The objective of this study was to systematically search through the last twelve years of research and gauge the influence of mirror exercise therapy on the sensory and motor handicaps of stroke patients who have become hemiparetic.

METHODS

Search Strategy

We made an unrestricted review of the Virtual Health Library (VML) based on the bibliographical databases of LILACS (2005 - September 2010), SciELO (2007 - 2011), MEDLINE (1966 - March 2011), and the National Center for Biotechnology Information, on the PubMed database (1999 - May 2011). The keywords we used in the research were: "mirror therapy" (therapy by exercise - selecting articles that used a mirror in therapy), visual "feedback", "stroke" (CVA), "pain", "rehabilitation", "functionality", and "dexterity". In addition, we did an active manual search in the bibliographies of the articles found.

Selection Criteria

The articles selected for this review were those that met the following inclusion criteria: to be a controlled, randomized clinical study; to cover individuals diagnosed with stroke; to be in physiotherapy treatment; to have used mirror therapy; to have a score of at least 4 on the PEDro scale; and to be written in either Portuguese, Spanish, or English.

Data Analysis

A standardized block of data was gathered from each article selected, and included information about the demographics of each patient, the type of study it was, the treatments involved, frequency of treatment, evaluations, components evaluated, and the results.

The comparison between the studies and the conclusions about the whole sample were based on the PEDro physiotherapy

evidence database,²⁰ scoring the items from 2 to 11.

Evaluation of Quality

The methodological quality of the studies was evaluated using the PEDro scale,²⁰ which consists of a scale of 11 items made to evaluate the methodological quality of randomized clinical tests. Each item equals 1 point (except the first one, which, contrary to the others, concerns external validity) in the scoring, which ranges from 0 to 10.²¹ The two aspects considered in the PEDro scale concern the internal validity and the interpretation of the results of the clinical studies.¹

RESULTS

Selecting the Study

The results from the search strategy were justified as follows: 25 articles were identified for possible inclusion in the study, but 19 were excluded for the following reasons: 6 were not compatible with the sample; 8 did not correspond to exercise therapy with a mirror; 1 did not get involved with treatment and 5 were review articles or case studies. Therefore, 5 studies fulfilled the inclusion criteria and were selected for the present study.

Characteristics of the Study

All the studies analyzed were of controlled, randomized, clinical studies.²²⁻²⁶ They were composed of diagnosed stroke patients of both genders. The demographics of the sample are shown in Table 1. The evaluation instrument most used was the Functional Independence Measure (FIM), which evaluates functional independence.¹² A complete list of the evaluation instruments, including the frequency with which they were used, is given in Table 2.

In Table 3 we find summarized information on each study: the type of study, the treatment, the frequency of treatment, evaluations, evaluation instruments, and results.

Methodological Quality

The scoring of the included studies ranged from 4 to 7 with an average of 6.2, with 4 being the cutoff point for inclusion, which is considered fair and acceptable. It was difficult to find blind studies, which justifies the number of articles encountered. The division of scores of the PEDro scale criteria of each study is available in Table 4.

Table 1. Demographic characteristics of the patients

Study	Sample	n	Stroke I/H	M/F	Average age/SD (yrs)	Time with Lesion (Stroke)
Altschuler et al. ²²	Stroke patients (at least 6 months)	9	7/2	4/5	58.2 +/- 6.41	4.8 years
Sütbeyaz et al. ²⁵	Stroke patients (at least 12 months)	TG = 20 CG = 20	TG = 16/4 CG = 17/3	TG = 10/10 CG = 17/3	TG = 62.7 +/- 9.7 CG = 64.7 +/- 7.7	TG = 3.5 +/- 1.3 (m) CG = 3.9 +/- 1.9 (m)
Yavuzer et al. ²⁶	Stroke patients (the last 12 months)	TG = 17 CG = 19	TG = 14/3 CG = 15/4	TG = 9/8 CG = 10/9	TG = 63.2 +/- 9.2 CG = 63.3 +/- 9.5	TG = 5.4 +/- 2.9 (m) CG = 5.5 +/- 2.5 (m)
Dohle et al. ²³	Stroke patients (last 8 weeks and occurring in the MCA region)	TG = 18 CG = 18	I Stroke in all patients, TG as well as CG	TG = 13/5 CG = 13/5	TG = 54.9 +/- 13.8 CG = 58.0 +/- 14.0	TG = 26.2 +/- 8.3 (d) CG = 27.8 +/- 12.1 (d)
Cacchio et al. ²⁴	Stroke patients (last 6 months) + Type 1 Complex Regional Pain Syndrome	TG = 24 CG = 24	TG = 18/6 CG = 17/7	TG = 11/13 CG = 11/13	TG = 57.9 +/- 9.9 CG = 58.8 +/- 9.4	TG = 5.1 +/- 2.5 (m) CG = 4.9 +/- 2.8 (m)

* Abbreviations: TG: test group; CG: control group; MCA: middle cerebral artery; I: ischemic; H: hemorrhagic; M: male; F: female; SD: standard deviation; m: months; d: days

Table 2. Evaluation instruments used in the five selected studies

Items Evaluated	Studies	Evaluation Instruments
AOM, speed of movement and dexterity	1	Evaluation by videotape
Sequence of motor recovery in stroke patients	2	Brunnstrom stages
Spasticity	2	Modified Ashworth Scale
Gait	1	Functional Ambulation Categories
Functional independence	3	Functional Independence Measurement
Pain	1	Visual Analogue Scale
Motor skill of the UL	1	Wolf Motor Function Test
Motor function of the UL	1	Motor Activity Log
Sensory-motor recovery	1	Fugl- Meyer test
Activities of the upper limb	1	Action Research Arm test

* Abbreviations: ROM: range of movement; UL: upper limb

Table 3. Characteristics of the selected articles

Study	Type of study/scoring	Treatment	Frequency	Evaluations	Evaluation Instruments	Results
Altschuler et al. ²²	CRCS PEDro: 4/10	TG = MET, with both limbs CG = MET, but with transparent plastic	15 min, 2x/day 6 days/week 4 weeks	5 evaluations: initial, after 2, 4, 6 and 8 months	Videotape	TG improved more than the CG
Sütbeyaz et al. ²⁵	CRCS PEDro: 7/10	TG = MET with the healthy limb, using the reflective side CG = MET with no reflective surface	30 min/day 5x/week 4 weeks	3 evaluations: initial, final and 6 months after conclusion	Brunnstrom MAS FAC FIM	Long-term benefits of MET in terms of recovery and motor function
Yavuzer et al. ²⁶	CRCS PEDro: 7/10	TG = MET with the healthy limb, using the reflective side CG = MET with no reflective surface	30 min/day 5x/week 4 weeks	3 evaluations: initial, final and 6 months after conclusion	Brunnstrom MAS FIM	MET was beneficial for function and motor recovery, but not for reducing spasticity
Dohle et al. ²³	CRCS PEDro: 6/10	TG = MET using the reflective side CG = therapy with no mirror; patient looked directly at the affected limb	30 min/day 5x/week 6 weeks	Initial and final	Fugl- Meyer FIM ARAT	MET in the acute phase of stroke resulted in better functionality, as much in motor as sensory aspects
Cacchio et al. ²⁴	CRCS PEDro: 7/10	TG = MET with the healthy limb, using the reflective side CG = MET with the reflective side covered with paper	For the first two weeks: 30 min/day In the last two weeks: 1h/day 5x/week 4 weeks	3 evaluations: initial, final and 6 months after conclusion	VAS MAL WMFT	MET significantly reduced pain and increased motor function of UL in stroke and RCPSt1 patients

* Abbreviations: CRCS: Controlled Randomized Clinical Study; TG: test group; CG: control group; ROM: Range of movement; MAS: Modified Ashworth Scale; FAC: Functional Ambulation Categories; FIM: Functional Independence Measure (program to evaluate rehabilitation results); MAL: Motor Activity Log; WMFT: Wolf Motor Function Test; ARAT: Action Research Arm test; MET: Mirror Exercise Therapy; UL: Upper Limb; RCPSt1: type 1 Regional Complex Pain Syndrome type

Table 4. Detailed scoring on the PEDro scale for each study

Study	Criteria										Scoring
	2	3	4	5	6	7	8	9	10	11	
Altschuler et al. ²²	S	N	S	N	N	S	N	N	N	S	4/10
Sütbeyaz et al. ²⁵	S	S	S	N	N	S	S	N	S	S	7/10
Yavuzer et al. ²⁶	S	S	S	N	N	S	S	N	S	S	7/10
Dohle et al. ²³	S	S	S	N	N	S	N	N	S	S	6/10
Cacchio et al. ²⁴	S	N	S	N	N	S	S	S	S	S	7/10
Total	5/5	3/5	5/5	0/5	0/5	5/5	3/5	1/5	4/5	5/5	-

* PEDro criteria: (2) subjects divided randomly into groups; (3) blind distribution of subjects; (4) initially, similar groups with respect to the most important diagnostic indicators; (5) blind participation of subjects; (6) blind administration of therapy by the physiotherapists; (7) blind participation of the evaluators who measured at least one key-result; (8) measures of at least one key-result were obtained in more than 85% of the subjects initially divided into groups; (9) subjects received treatment or there was intention to treat at least one of the key-results; (10) comparison between the groups for at least one key-result; (11) the study present measures of precision as well as measures of variability for at least one key-result.

DISCUSSION

The purpose of this review was to seek out and analyze scientific evidence on the mirror exercise therapy being used to treat stroke victims.

The study by Altschuler et al.²² evaluated dexterity, range, and speed of movement. As an evaluation tool, the patients were filmed while they performed their arm movements in the three planes. From these films the two evaluators used their own scale to analyze the items being evaluated. The sample consisted of nine individuals medically diagnosed with stroke. These nine patients participated as much in the test group as in the control group, for four weeks in each group. In the test group, the mirror exercise therapy was done with patients moving both arms/hands symmetrically while looking at the healthy arm in the mirror. In the control group, the patients followed the same procedure, except they looked at a transparent piece of plastic. After the study was over, the evaluators both confirmed that the patients had improved more in the test group than in the control group. The authors did not specify their sampling criteria for the control group because when they did their re-evaluation they used their own scales. Even so, considering the PEDro scale, their work was included due to the methodological criteria of the present study.

The study by Sütbeyaz et al.²⁵ evaluated the sequence of motor recovery in stroke patients along with spasticity, gait, and functional independence. Their sample consisted of 40 individuals, which were divided into one control group and one test group. The test group made plantar and dorsal flexion movements with the healthy limb facing a mirror positioned perpendicular to the person's midline. The control group made the same movements, however, facing a non-reflective

side. The frequency of treatment was the same for both groups (30 minutes/day, 5x per week, 4 weeks). The results of all the parameters evaluated showed significant improvement in both groups at the conclusion, and again six months post-treatment. The components that improved the most significantly six months post-treatment in the test group were the functional independence ($p = 0.001$) and motor recovery ($p = 0.002$), consistent with the neuromotor adjustments during the physiotherapy sessions in clinical practice.

The study by Yavuzer et al.²⁶ used the same sample selection criteria, frequency, and treatment as the previous work²⁵ with only one difference in relation to the limbs, which here were the upper limbs. Both works utilized the Functional Independence Measure and observed that the motor recovery of the UL and functional independence of the test group obtained better significant improvement in the long run, that is, six months post-treatment ($p = 0.001$).

In contrast, the work by Dohle et al.²³ gave importance, in relation to the inclusion criteria, only to those with acute stroke, and the treatment was extended by two more weeks. The sensory-motor recovery, functional independence, and activities of the upper limbs were the components evaluated. A motor function and sensory improvement ($p = 0.009$) was observed in the final evaluation of the test group.

In the studies of Sütbeyaz et al.²⁵ and Cacchio et al.²⁴ treatment for the upper limbs was emphasized, keeping the same method and frequency of treatment as in the study cited above. Except in the last two weeks in the study by Cacchio et al.²⁴ the treatments were lengthened by 30 minutes. Both obtained an improvement in motor function and the work by Cacchio et al.²⁴ also saw an improvement in the pain situation, which was one of the items evaluated.

It was observed in the present review that all the studies encountered had an improvement in motor function, but few reported any improvement in pain. It is not known whether the presence of pain was a selection criterion of those studies since in the studied population one of the biggest complaints is of pain in the limbs and functional motor disability.

CONCLUSION

As argued in the present study, mirror therapy is beneficial to motor recovery, motor-sensory function, and the diminution of pain when it is done 5 times a week.

Stroke victims need physiotherapy, and of course the amount of therapy can influence motor learning as well as neural plasticity. In practice, the reality of the patients treated in the rehabilitation center is inconsistent with the quantity of therapy done in these cited studies.

We know the importance of intensive stimulation in augmenting the adaptive capacity of the Central Nervous System in response to experiences, adaptations, and various conditions of repeated stimuli. Above all, we conclude that it is necessary to follow this protocol less frequently regarding the days per week to show future results consistent with the reality in the rehabilitation center.

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