



The variety of methodology in Mirror Therapy practice for improving hand function after stroke

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Alina Radajewska¹, Józef Opara^{2, 3}, Krzysztof Mehlich^{2,3}

1.Department of Ambulatory Physiotherapy, The Health Centre in Krapkowice, Poland

2.Department of Physiotherapy, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

3.The "Repty" Rehabilitation Centre in Tarnowskie Góry, Poland

Abstract

Many studies have shown that a repeated exercises in the mirror visual feedback and motor imagery conditions may help to restore a lasted hand function in stroke patients. The evidence of effectiveness of mirror therapy is promising but the use of this method varies widely within studies. It has been postulated that there is a need to formulate basic rules of mirror therapy application with respect to different stages of stroke or severity of hand paresis. In this article the review of methodological variability of applying mirror therapy to patients after stroke has been presented. The review highlights the benefit effect of mirror therapy on motor recovery and activities of daily living after stroke.

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Corresponding author

Alina Radajewska,

ul. Szkolna 7, 47-300 Krapkowice Poland

alinaradajewska@gmail.com, ,

tel. 774467020

INTRODUCTION

The hemiparesis is a very frequent dysfunction due to ischemic stroke. Over 60% of stroke survivors suffer from durable symptoms of focal damage of brain, what limits their engagement in activities of daily living (Duncan, 2005). Mirror therapy (MT) is an alternative way to create a visual illusion of a proper movement in paretic hand after stroke. The theoretical mechanisms of mirror therapy are supported by mirror neuron system activation in the brain what may stimulate a cortical reorganization (Rizzolatti and Arbib, 1996). Other of neuroscientific theories on the underlying working mechanisms, is that the visual pathways to the brain override a lack of sensory input (Garry et al., 2005; Fukumura et al., 2007; Altschuler et al., 1999; Dohle et al., 2009). Several imaging studies have shown cortical changes after MT, restoring sensorimotor representation of the affected limb (Garry et al., 2005; Fadiga and Craighero, 2004; Dohle et al., 2004; Tomaniga et al. 2009).

The origin of this novel approach was presented firstly in the 90s, as a method used to relieve a phantom limb pain in amputees people who have a lack of congruence between information output (motor command) and inadequate visual feedback (Ramachandran and Rogers-Ramachandran, 1996). Next recorded innovative use of mirrors to restore a hemiparesis after stroke (Altschuler et al., 1999). This initial studies presented a beneficial effect of mirror visual feedback (MVF). Afterwards further studies were published which supported the previous results. The majority of studies included a chronic stroke population. The evidence of effectiveness of mirror therapy is promising but the use of this method varies within studies.

The idea of mirror therapy is focused on unusual mirror setting in the midline of the body, which completely changes the visual perception of affected side of the body. Thanks to it, the watching movement of the healthy limb in the mirror reflection, creates the visual illusion of proper movement in the affected limb (Altschuler et al., 1999; Ramachandran and Rogers-Ramachandran, 1996). On the other side, when there is the lack of the visual feedback while performing the action, it is not possible to release processes associated with the successful functioning of the paretic limb (Steven and Stoykov, 2004). Rizzolatti and Craighero (2004) have described the mirror as a tool used to create an image of proper motion in neuropsychological aspects. Also, the huge role of visual feedback created from the mirror reflection is postulated in many of reports. It is necessary to consider some practical points, that have been reported in the literature.

METHODOLOGICAL ASPECTS OF PRACTICAL IMPLEMENTATION OF THE MIRROR THERAPY IN STUDIES:

In the literature a different movement character have been presented during MT practice. There are described a different possibilities for the non-affected limb and a different possibilities for affected limb.

In case of non-affected limb some reports has presented transitive character of being observed movements. In this approach the patient is focusing on object-related task (Beis et al., 2001; Gyax et al., 2011). Other reports has presented intransitive character of being observed movements, when the patient is focusing on simple abstract movements execution (Altshuler 1999; Yavuzer et al., 2008, Invernizzi et al., 2013; Radajewska et al., 2013). Thieme et al. (2013) states that the patients had more difficulties with the execution and even had a less vivid illusion in using transitive movements during MT practice. However, still is no recommendation which movement character should be used in MT.

In case of affected limb there are three possibilities of task during MT practice. Several studies have presented "no movement" of affected limb and they have based only on observation of healthy hand movements without any engagement of the affected arm (Stevens and Stoykov 2004) . The theoretic background of this approach is that the excitability of the ipsilateral M1 during the unilateral hand movement is facilitated by viewing of the image of the hand moving in a mirror. Modulation of the excitability of the M1 area is an important mechanism associated with the stimulation of neuronal neuroplasticity (Butefisch et al., 2004; Muellbacher et al., 2002).

Other studies have presented "active movement" of both hand, but the affected one "as good as possible" (Altschuler 1999; Sathian et al., 2000; Stevens and Stoykov, 2004; Dohle et al., 2008; Radajewska et al., 2013). That kind of movement character of affected limb is addressed for patients with moderate paresis following stroke to created conditions of motor copy strategy of bimanual movements, which results in a subsequent improvement in the "forced use" of paretic hand.

The third possibility for the affected limb has been demonstrated in few studies as a "passive movement providing by therapist". A therapist providing movement of affected limb passively in a synchronal way while the patient moves the non-affected limb (Miltner et al., 1999; Fukumura et al., 2007). That kind of movement character of affected limb is addressed for patients with severe paresis following stroke to created conditions of quasi-bimanual training.

MOTOR IMAGERY AS AN ADDITIONAL ASPECT BEFORE MT TRAINING FOR PATIENTS WITH SEVERE HAND PARESIS

Stevens and Stoykov (2004) demonstrated that motor imagery supported by a MVF brings benefits in the rehabilitation of severe paretic of a hand. They conducted the participants previous action observation

of the recorded movement of a hand. The authors postulated that there is an intimate connection between the motor imagery and performing the action. The authors suggest that the creation of the feeling like the paretic limb is moving accordance to the good hand, initiates a cognitive and neural processes associated with the successful functioning of the paretic limb.

BILATERAL OR UNILATERAL TRAINING?

Some of the reports are suggested that the perception of the participants should be focused on bimanual, symmetrical movements what minimizes the attention on each hand movement sequences separately. They have used functional Magnetic Resonance Imagination (fMRI) to measure the effect of bilateral and unilateral movements in the paretic hand. The results confirmed that the acute phase of recovery, increase activation of bilateral movements in the primary motor cortex of the affected hemisphere. In the chronic phase the improvement may be the result not only the bimanual movement, but also peripheral changes such as an increase of muscle tone or decrease of muscle spasticity. Stevens et al. (2004) also have shown that bimanual movement training promotes the interhemispheric disinhibition, it enables reorganization of neuronal level. Dugué et al. (2005) have stressed that the most important aspect while bimanual movement performing and while the mirror image observation is to encourage the patient to moving paretic limb, as much as it is possible (in Hesse, et al., 2007). Byblow et al. (2012) found that mirror symmetric active-passive bimanual movement increases the corticomotor excitability of the passive hemisphere also in healthy participants. In contrast stated the study by Selles et al. (2014), they indicated that bimanual movement using mirror training was less effective than unilateral training in stroke patients.

Summers et al. (2007) compared the efficacy of bilateral and unilateral training. They found that the intervention using bilateral training is more effective in regain the motor function. Carson also supported the involvement of the healthy hand movement and an introduction of bimanual exercises into the rehabilitation of the paretic hand (2005). He examined the potential of bilateral synergisms of different areas of the brain while performing bimanual movements. They suggested that when the healthy limb is involved in the locomotor training, there is an increase in the excitability of the homologous motor pathways of the paretic limb; it is possible that paving the functional improvement is facilitated through the healthy hemisphere.

THE FIRST USE OF MT IN EARLY STAGE AFTER STROKE (PATIENT-LED THERAPY)

Interesting pragmatic randomized controlled study by Tyson et al., were published in 2015. They have assessed the usefulness and acceptance of patient-

led upper limb training with mirror therapy use and without mirror therapy and patient-led lower limb training at home conditions. They evaluated motor function of upper and lower limb and also a neglect. The methodology of study they based on a protocol of study of Michielsen et al. (2011). The subjects have individually recommended a level of training intensity and they were informed to practice every day for 30 minutes per day, during 28 days. The participants were asked to refer the real time they were spending on the therapy. In the results all study groups did less therapy session then they have recommended. The linear regression indicated, that the patients with neglect had practice less then patients without neglect in mirror therapy groups. That effect was not reported in the lower limb study group. In the conclusion the authors assessed the real time for mirror therapy practice in single session as a 5 to 15 minutes per day. This time of session duration they accepted for optimal to do in home practice as a patient-led therapy after stroke in acute stage.

RECENT REVIEW

Thieme (2012) et al. summarized the current research based on the Cochrane Systematic Review. The study included RCTs and cross-over RCTs, and was done to assess the effectiveness of MT as an additional treatment compared to sham therapy i.e. without extra exercises. The basis for the assessment was the motor function of the hand measured on different scales, such as Fugl-Meyer (FMA), Action Research Arm Test (ARAT), Wolf Motor Function Test (WMFT) or Brunnström. Secondly, they focused on the assessment of ADLs on such scales as the Barthel Index and the FIM, the pain assessment and the spatial neglect. The search was undertaken by two independent researchers in a manual and electronic way. In agreement with the specialist, the quality of the studies, chosen for the analysis from the group of selected research, was assessed using the following tools: the RevMan Bias Tool and the Pedro Scale. As a result, among 18000 qualified literature items, 12 RCTs and 2 cross-over RCTs were qualified for the review, out of which 13 were included in meta-analysis. The size of the compared samples ranged from 9 to 121 patients, and 567 patients after stroke altogether. Five studies compared MT with the same workout of both hands, but with unrestricted views of the sick hand, and six with a view of the sick hand veiled with the non-transparent material. Other studies compared MT with electrostimulation or the results of studies without additional hand exercises. The methodological quality ranged from 1-8 points on the Pedro Scale. The median was 7 points indicating the good quality of most qualified research. All included studies related to the chronic period, more than 3 months after the onset, the intensity of MT varied from 60 minutes to 2000 minutes. The authors also showed that the type of the control treatment also affects an

improvement; the control group treated with the sham intervention reported the most intense change among the reviewed studies.

SUMMARY

Many studies have demonstrated the effectiveness of MT as an additional therapy in the treatment of the upper extremity after stroke as well as on ADLs in various stages of recovery. The effects of this novel approach is promising due to its aim to restore lost

function using a brain plasticity. The mirror therapy is an intervention used as an additional treatment with the possibility of bilateral or unilateral hand exercises; it is also combined with other therapeutic strategies. The diversity of both methodology and the selection of control therapy hinders drawing general conclusions. Further randomized control studies should focus on determining the intensity of the therapy, its frequency and presenting patient details, such as the time that elapsed from the onset or the severity of paralysis.

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