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Review article

Systematic review of the effectiveness of mirror therapy for treatment of mentally ill patients

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Abstract

In mirror therapy (MT), the patient sits in front of a mirror that is oriented parallel to his midline blocking the view of the (affected) limb, positioned behind the mirror. When looking into the mirror, the patient sees the reflection of the unaffected limb positioned as the affected limb. This arrangement is suited to create a visual illusion whereby movement of or touch to the intact limb may be perceived as affecting the paretic or painful limb. The aim of this review was to identify and summarize the existing evidences on mirror therapy for the management of mental illness in patients. A systematic literature search was performed to identify studies concerning mirror therapy. The included journal articles were reviewed and assessed for its significance. Twenty-two studies were identified and reviewed. Five different patient categories were studied: Two studies focussed on mirror therapy after stroke, two studies focussed on mirror therapy with complex regional pain syndrome patients, one studies on mirror therapy for cerebral palsy and on study on mirror therapy for mental illness. The articles reviewed showed a trend that mirror therapy is effective in stroke, phantom limb pain, complex regional pain syndrome, mental illness and cerebral palsy.

Key words: Mirror therapy, mental illness, clinical interpretation

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1. Introduction

In Mirror therapy, a patient is allowed to feel the imaginary movement of the removed body part behaving as normal body movement through a mirror [1]. Mirror therapy used in an attempt to help those with phantom limb pain resolve what they termed a 'learned paralysis' of the painful phantom limb. The visual feedback, from viewing the reflection of the intact limb in place of the

phantom limb, made it possible for the patient to perceive movement in the phantom limb. Their hypothesis was that every time the patient attempted to move the paralyzed limb, they received sensory feedback (through vision and Proprioception) that the limb did not move. This feedback stamped itself into the brain circuitry through a process of Hebbian learning, so that, even when the limb was no longer present, the brain had learned that the limb (and subsequent

phantom) was paralyzed [1]. The mirror image of the normal body part helps reorganise and integrate the mismatch between proprioception and visual feedback of the removed body. Thus, enhancing the effective treatment for phantom limb pain. The clinical effect of mirror therapy is much more significant than any other treatments [2, 3]. Mirror neuron was used to explain the fundamentals of a mirror therapy [4]. At first, a mirror neuron was found in the monkey premotor cortex, and later, discovered that humans also have similar mirror neurons systems [5]. A mirror neuron fires both when a person acts and when a person observes the same action performed by another. Then, the neuron mirrors the behaviour of the other, as though the observer were itself acting. A mirror neuron provides observers with internally recognised experiences, making them understand other's behaviours, intentions, and emotional status [4, 5].

Therefore, while mimicking the behaviour of the other, observers can experience not only the sensation, but also the similar emotion of the other. In this sense, a patient with phantom limb pain can feel the same sense or emotion of his/her normal body part by observing the mirror image. By doing so it is expected to decrease pain by resolving conflict between motor intention, proprioception and visual system. A Mirror box is a device which allows the clinician to easily create this illusion. It is a box with one mirror in the centre where on each side of it, the hands are placed in a manner that the affected limb is kept covered always and the unaffected limb is kept on the other side whose reflection can be seen on the mirror. MT is a non-pharmacological and alternative treatment strategy that has been proposed as a means of managing phantom limb pain. It is a neurorehabilitation technique designed to remodulate cortical mechanisms. With this technique, patients perform movements using the unaffected limb whilst watching its mirror reflection superimposed over the (unseen) affected limb. This creates a visual illusion and provides positive feedback to the motor cortex that movement of the affected limb has occurred. The approach is thought to offer potential relief through the visual dominance upon motor and sensory processes [6].

With the application of mirror therapy to these different types of pathological conditions, each with their own type of mental illness from which it emerges and underlying type of disorder, the question arose regarding the effectiveness of mirror therapy with all these different types of patients.

The current article evaluated with which types of patients mirror therapy was effective.

This serves at least two purposes:

Information about the effectiveness of mirror therapy is relevant for the clinical practice because it can be determined for which patients this therapy might work. Second, establishing the type of patient groups with which mirror therapy is effective should allow for a better understanding of the underlying working mechanisms of mirror therapy. Understanding the working mechanisms of mirror therapy is useful in determining the (new) types of patients for who mirror therapy might be helpful. To examine the extent to which mirror therapy was effective we performed a systematic analysis of the literature into the effectiveness of mirror therapy in mentally ill patients. Mirror therapy has been used in patients suffering from stroke, cerebral palsy, complex regional pain syndrome, phantom limb pain and fracture rehabilitation. Three particular conditions that have been studied the most are stroke, CRPS and phantom limb pain. During mirror therapy, a mirror is placed in the patient's mid sagittal plane, thus reflecting movements of the non paretic side as if it were the affected side. This arrangement is suited to create a visual illusion whereby movement of or touch to the intact limb may be perceived as affecting the paretic or painful limb. The underlying mechanisms of the effects in these three patient groups have mainly been related to the activation of 'mirror neurones', which may also be activated when observing others perform movements and also during mental practice of motor tasks. Mirror neurons were found in areas of the ventral and inferior premotor cortex associated with observation and imitation of movements and in somatosensory cortices associated with observation of touch. These cortical areas are supposed to be activated by MT. Until now, direct evidence for the mirror-related recruitment of mirror neurons is lacking.

Other potential mechanisms such as enhanced self-awareness and spatial attention by activation of the superior temporal gyrus have been proposed. The superior temporal gyrus is also thought to play an important role in recovery from neglect, and is activated by observation of biological motion.

Searching engines and criteria

An Independent search was performed by researchers using a well defined search strategy in following databases; Pubmed, EBSCO, DOAJ, Science Direct and Google Scholar published from 1996 to 2016 using the key terms mirror box, mirror box therapy, mirror therapy and mental illness. All randomized controlled trials (RCTs), cohort, case controlled studies, single case studies and case series were used in evaluating the clinical aspects of mirror therapy. All age groups and both females and males were included for selection of reviews. Only physiotherapy intervention has been included, no medical or surgical intervention or comparison with any other alternative therapies. Visual analogue scale, range of motion, numerical pain rating scale, grip strength, wrist functionality measurements, timed performance tests, functional independence measure, modified Ashworth scale, functional ambulation categories, functional independent measure, wolf motor function test, motor activity log, Fugl- Meyer test, behavioral inattention test, test of attention performance, manual muscle testing, manual functional test, action research arm test, box and block test and 10-meter walk test were taken as an outcome measures. A total of twenty three studies were potentially identified by the authors. Studies published in English language on effectiveness, efficacy, effects of mirror box therapy were included in the review. MT was used in conditions like stroke, cerebral palsy (CP), complex regional pain syndrome (CRPS), phantom limb pain (PL) and mental illness.

Mirror therapy in stroke

A pilot study was to assessed to find the effectiveness of Mirror Therapy to improve

hand functions in acute and sub-acute stroke patients. In a pre-test-post-test single-group design, a convenience sample of 11 of acute and sub-acute stroke patients at Department of Physiotherapy, in Pad. Dr. Vikhe Patil Hospital, Ahmednagar. Participants received a Mirror Therapy program, performing various movements by the less affected upper extremity and observing in the mirror box along with conventional management, 4 days per week for 4 weeks. Fugl-Meyer Assessment (FMA), which includes subsection hand (FMA-WH), Wolf Motor Function Test (WFMT-WH) were used as an outcome measure. Participants showed significant improvement for FMA-WH and WFMT-WH at post assessment. WFMT-WH changed from 7.545 to 15.727. ($p < 0.0001$) (Fig 1) whereas FMA-WH changed from 34.18 to 47.36. ($p = 0.0002$) (Fig 2) [8].

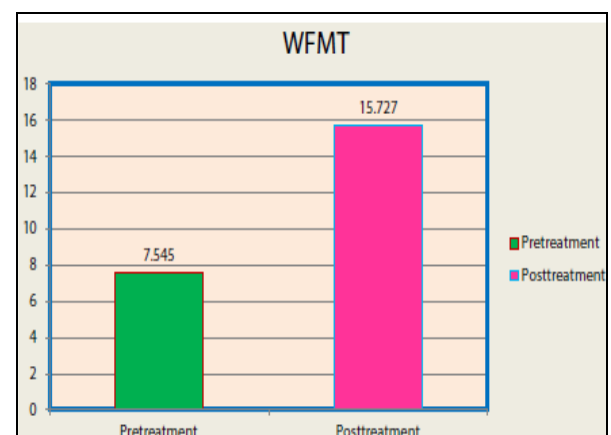


Fig 1: Comparison of WFMT score pre and post intervention 4th week.

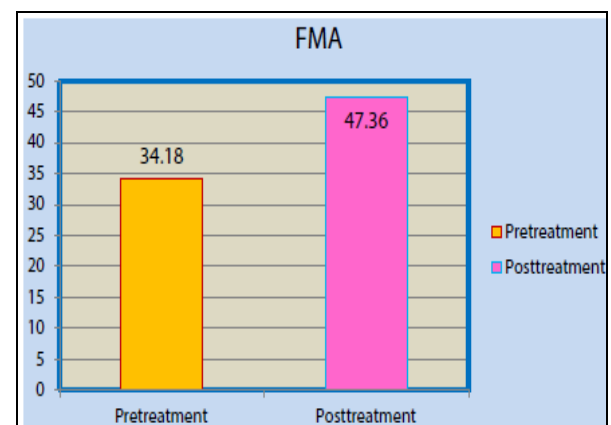


Fig 2: Comparison of FMA score pre and post intervention 4th week.

A study evaluated the effects of a very early mirror therapy program on functional improvement of the upper extremity in acute stroke patients. Eight stroke patients who were treated in an acute neurology unit were included in the study. The patients were assigned alternatively to either the mirror therapy group receiving mirror therapy and neurodevelopmental treatment or the neurodevelopmental treatment only group. The primary outcome measures were the upper extremity motor subscale of the Fugl-Meyer Assessment, Motricity Index upper extremity score, and the Stroke Upper Limb Capacity Scale. Somatosensory assessment with the Ayres Southern California Sensory Integration Test, and the Barthel Index were used as secondary outcome measures. No statistically significant improvements were found for any measures in either group after the treatment. In terms of minimally clinically important differences, there were improvements in Fugl-Meyer Assessment and Barthel Index in both mirror therapy and neurodevelopmental treatment groups. The results of this pilot study revealed that very early mirror therapy has no additional effect on functional improvement of upper extremity function in acute stroke patients. Multicenter trials are needed to determine the results of early application of mirror therapy in stroke rehabilitation [9].

Mirror therapy in phantom limb pain:

The two studies that investigated the effects of MT [10] and graded motor imagery (Moseley, 2006) on PLP in patients following amputation of the upper or lower limb or brachial plexus avulsion, found positive results regarding patient-specific functions [11] and pain intensity and number and duration of pain episodes [10,11]. Unfortunately, the description of study characteristics in the publication of [10] was sparse. A case study first reported successful treatment of bilateral phantom limb pain (PLP) in a patient with bilateral thigh amputation and inefficacious medical treatment using a protocol of graded interventions including mirror therapy (MT). This study illustrated how application of a unilateral prosthesis sufficed to induce the necessary illusion. After sequential imagery, then lateralization training, which alleviated

pain attacks, the patient received a further 3 – week treatment of mirror treatment. Pain intensity was reduced by more than 85%; the number of attacks was decreased by more than 90% per day. The analgesic efficacy lasted until the unexpected death of the patient several months later. This case illustrates the mechanisms of MT through overcoming the sensory incongruence's underlying the disorted body schema and its efficiency in patients with bilateral [12]. A study investigated the effects of daily mirror training over 4 weeks in 13 chronic PLP patients after unilateral arm amputation. Eleven participants performed hand and lip movements during a functional magnetic resonance imaging (fMRI) measurement before and after MT. The location of neural activity in primary somatosensory cortex during these tasks was used to assess brain changes related to treatment. The treatment caused a significant reduction of PLP (average decrease of 27%). Treatment effects were predicted by a telescopic distortion of the phantom, with those patients who experienced a telescope profiting less from treatment. fMRI data analyses revealed a relationship between change in pain after MT and a reversal of dysfunctional cortical reorganization in primary somatosensory cortex. Pain reduction after mirror training was also related to a decrease of activity in the inferior parietal cortex (IPC) [13].

Mirror therapy in cerebral palsy

A study tested the effectiveness and feasibility of mirror therapy in children with hemiplegic by performing a pilot crossover study in ten participants (aged 6-14y; five males, five females. Manual Ability Classification System levels : one at level I, two at level II, four at level III, three at level IV) randomly assigned to 15 minutes of daily bimanual training with and without a mirror for 3 weeks. The first group started by using a mirror therapy box (Reflex Pain Management Ltd, Stockport, UK), placing the paretic limb in the box and looking at the reflection of the non-paretic limb in the mirror and the second group trained without a mirror box (sham condition) for 3 weeks before crossover for a further 3 weeks (Fig. 3). Assessments of maximal grasp and pinch strengths, and upper limb function measured by the

Shriner's Hospital Upper Extremity Evaluation were performed at weeks 0 (baseline), 3, 6 (intervention), and 9 (wash-out). Testing of grasp strength behind the mirror improved performance by 15% ($p=0.004$). Training with the mirror significantly improved grasp strength (with mirror +20.4%, $p=0.033$; without +509%, $p>0.1$) and upper limb dynamic position (with mirror +4.6%, $p=0.044$; without +1.2%, $p>0.1$), while training without a mirror significantly improved pinch strength (with mirror +6.9%, $p>0.1$; without +21.9%, $p=0.026$). This preliminary study demonstrated the feasibility of mirror therapy in children with hemiplegic cerebral palsy and that it may improve strength and dynamic function of the paretic arm [14].



Fig 3: Mirror therapy box by placing the paretic limb in the box [14]

Mirror therapy in CRPS

Complex regional pain syndrome type (CRPSt1) of the upper limb is a painful and debilitating condition, frequent after stroke, and interferes with the rehabilitative process and outcome. A randomized controlled study was conducted to compare the effectiveness on pain and upper limb function of mirror therapy on CRPSt1 of upper limb in patients with acute stroke. Of 208 patients with first episode of unilateral stroke admitted to the rehabilitation center, 48 patients with CRPSt1 of the affected upper limb were enrolled in a randomized controlled study, with a 6-month follow-up, and assigned to either a mirror therapy group or placebo control group. The primary end points were a reduction in the visual analogue scale score of a pain at rest, on movement, and brush-induced tactile allodynia. The secondary end points were

improvement in motor function as assessed by the Wolf Motor Function Test and Motor Activity. The mean scores of both the primary and secondary end points significantly improved in the mirror group ($P<0.001$). No statistically significant differences after treatment ($P<0.001$) and at the 6-month follow-up were found between the 2 groups. The result indicate that MT effectively reduces pain and enhances upper limb motor function in stroke patients with upper limb CRPSt1 [15]. Altschuler E. et al examined mirror therapy in a patient with a fractured wrist and no active wrist extension. Patient was trained by moving both hands while watching the reflection of the present or good hand in a parasagittal mirror. Mirror therapy found extremely useful after a fractured wrist [16].

Mirror therapy for mental illness

A study aimed to establish the effectiveness of adherence therapy (AT) training for two multidisciplinary early interventions in psychosis (EIP) teams in preventing relapse in their patients. This intervention involved six 1 day team AT training sessions delivered monthly over a 6-month period. Participants were patients with early psychosis who were on the caseload of the EIP teams during the study period. A mirror-image design was used, comparing clinician ratings of relapse in the year preceding training (year 0) and the subsequent year (year 1). Results showed that in year 0, the mean number of relapses was 0.96. During year 1, Relapses reduced significantly. No unexpected effects training were reported. A thematic analysis of staff views of training, and service user's views of their care received from EIP teams, was also completed. Challenges in faithfully incorporating AT skills into practice were reported. In conclusion, AT training coincided with reductions in relapse rates in patients receiving services from an EIP team, but no other changes in outcomes were detected [17].

Clinical Interpretation

This literature review has given an account of the reasons for the widespread use of mirror therapy. Some of the potential limitations of this review were the lack of meta-analysis

and quality scoring of the included studies. A study summarized the current evidence supporting use of Mirror Box Therapy and its successor, Immersive Virtual Reality. They showed, in recent years the Phantom Limb Pain (PLP) and to some degree Complex Regional Pain Syndrome (CRPS) may prove to be an exception [18]. A study reviewed twenty three articles and concluded that the, mirror therapy seems to be effective mainly for patients. Overall, the current systematic literature review has shown that the use of mirror therapy in rehabilitation seems promising, when combined with stroke patients, while the effectiveness in other patient groups has yet to be determined [19]. Mirror therapy has shown positive effects in the treatment of stroke rehabilitation and complex regional pain syndrome. It also shows positive effects on hand and foot rehabilitation following an injury or surgery [20, 21].

Remarks of review:

Twenty three randomized studies are included in this systematic review. Studies use different measures at different times and often include small numbers of unrepresentative patients. In addition, important clinical aspects of MT interventions such as a detailed description of the treatment protocol and possible side effects are only insufficiently addressed. Because of the heterogeneity of included studies this was not possible in our study. In stroke patients, we found a moderate quality of evidence that MT as an additional therapy improves recovery of arm function after stroke. The quality of evidence regarding the effects of MT on the recovery of lower limb functions is still low, with only one RCT [22] reporting effects. In patients with CRPS and PLP, the quality of evidence is also low [23]. Some of the potential limitations of this review were the lack of meta analysis and quality scoring of the included studies. This review included studies of all designs leading to heterogeneity in not only interventions, outcome assessment and follow-up, but in analysis and effect size. Only studies in English were reviewed and this might have missed some other important studies. The increased variability regarding different physiotherapy modalities, comparison interventions, follow-

up, and outcome measures also made it very difficult to compare results across studies and draw relevant conclusions. Further good quality controlled clinical trials on comparison between the physiotherapy modalities and lifestyle modification are necessary to derive valid conclusions.

Conclusion

The articles reviewed showed a trend that mirror therapy is effective in stroke, phantom limb pain, complex regional pain syndrome, cerebral palsy and fracture rehabilitation. This study facilitates the author to understand the use of MT, its feasibility and applicability in the management of patients' with mental illness.

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