Effectiveness of Mirror Therapy in Recovery of Functional Movement after Stroke

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Effectiveness of Mirror Therapy in Recovery of Functional Movement after Stroke

Disciplines
Occupational Therapy

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Effectiveness of Mirror Therapy in Recovery of Functional Movement After Stroke

Prepared by: Christine Harrison-Beard
Date: October 2011
Review date: October 2013

CLINICAL SCENARIO: Cerebrovascular accident (CVA) is the leading cause of long-term disability and third-leading cause of death in the U.S., according to the National Institute of Neurological Disorders and Stroke (NINDS). Considering that 75% of all CVAs strike older adults (NINDS) and the first of 78-million baby boomers are turning 65 (Love, 2010), discerning best practice in stroke rehabilitation must be a top priority. Is there a role for mirror therapy (MT) in rehab for some stroke patients? MT is simple to perform, cost-effective and client-directed. Many of the clients I now see in an outpatient occupational therapy clinic have hemiparesis in their upper extremities but are otherwise healthy and motivated. These traits led me to wonder whether mirror therapy might help these clients regain functional movement and more actively participate in meaningful life activities.

FOCUSED CLINICAL QUESTION: How does mirror therapy impact occupational function in clients who have suffered stroke?

SUMMARY of Search, ‘Best’ Evidence’ appraised, and Key Findings:
A total of 5 research articles were analyzed from the literature investigating the impact of mirror therapy on motor function in clients who suffered stroke:

- 1 systematic review (Rothgangel et al., 2011) which concluded: “moderate evidence” exists that mirror therapy, combined with conventional therapy, improves motor function in the upper extremity after stroke.
- 4 randomized-controlled trials, all of which compared conventional therapy plus mirror therapy to conventional therapy alone. All achieved more improvement with MT.
- 3 of the 4 investigated the impact of MT on upper extremity function (1 each which focused on clients in the acute, subacute and chronic stage of stroke recovery). All achieved more favorable results adding mirror therapy compared to conventional therapy alone (Dohle et al. 2009; Yavuzer et al. 2008; Michielsen et al. 2011).
- 1 investigated the impact of MT on lower extremity function (Sutbeyaz et al 2007)

BEST EVIDENCE: An assessor-blinded, randomized controlled trial with 40 subjects all within 12 months of their stroke (Yavuzer et al, 2008). All subjects had severe motor impairment in the upper extremity without major cognitive deficits. During a 4-week trial both the mirror therapy (MT) and control therapy (CT) groups received conventional therapy (5 days a week, 2-5 hours each day) and an additional 30-minutes/5-days a week of MT or “sham” therapy. The MT group made statistically significant improvements over the CT in motor recovery of the arm and hand, as well as in scores for self-care. The gains persisted at the 6-month follow-up.

CLINICAL BOTTOM LINE: Patients who engage in mirror therapy realize greater recovery of function in their upper extremities than those who receive conventional therapy alone. This
can have a positive impact on a person’s ability to perform self-care routines, such as bathing, dressing, grooming and self-feeding. Although not addressed in the research, functional recovery may also result in greater self-efficacy and more active engagement in all aspects of one’s life.

**Limitations of this CAT:** This critically appraised topic has not been peer-reviewed and the author is not an expert in this topic area. The search was not exhaustive and was conducted as part of a class assignment by a 2nd year MOT student.

**SEARCH STRATEGY:**

Terms used to guide Search Strategy:
- **P**atient/Client Group: Stroke patients
- **I**ntervention (or Assessment): Mirror therapy
- **C**omparison: N/A
- **O**utcome(s): Functional recovery

<table>
<thead>
<tr>
<th>Source (database)</th>
<th>Search terms / Strategies</th>
<th>Inclusion / Exclusion Criteria</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>CINAHL</td>
<td>Mirror AND therapy AND stroke</td>
<td>Jan 2000-Sept 2011 English only Peer reviewed Full text available</td>
<td>Returned 10 citations 2 were helpful: Michielsen ME (2011) <em>Journal of Neurology, Neurosurgery &amp; Psychiatry</em> Ezendam D, Bongers RM, Jannink MJA (2009) <em>Disability &amp; Rehabilitation</em></td>
</tr>
</tbody>
</table>
### OT SEARCH
- Mirror therapy AND stroke.

### AGE LINE
- Mirror AND therapy AND stroke (in title)

### CINAHL
- Mirror AND therapy AND stroke
- Hand search based on references in Rothgangel (2011)

<table>
<thead>
<tr>
<th>Year</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-2011</td>
<td>Journal articles only – English. Match left to right.</td>
</tr>
<tr>
<td>2008-2011</td>
<td>All words in title</td>
</tr>
</tbody>
</table>

**Returned 1 citation**
- Sutbeyaz S (2007) Archives of Physical Medicine & Rehabilitation

**Returned 26 citations**
- 8 repeats
- 3 were helpful:
  - Burns (2008) Topics in Stroke Rehab
  - Stevens (2004) Topics in Stroke Rehabilitation

### INCLUSION and EXCLUSION CRITERIA
- **Inclusion:**
  - English language
  - Use of mirror therapy with stroke
  - Use of mirror therapy with adults
  - At least one outcome measure investigating motor recovery after mirror therapy
- **Exclusion:**
  - Articles written in any language other than English
  - Mirror therapy in conditions other than stroke
- Mirror therapy used with children
- Articles focused exclusively on mechanisms by which mirror therapy may work (mirror neurons, motor imagery, etc.)
- Articles focused exclusively on cortical reorganization after mirror therapy

RESULTS OF SEARCH
5 relevant studies were located and categorized as shown in Table 1 (based on Levels of Evidence, Center for Evidence Based Medicine, 1998)

Table 1: Summary of Study Designs of Articles retrieved

<table>
<thead>
<tr>
<th>Study Design/ Methodology of Articles Retrieved</th>
<th>Level</th>
<th>Number Located</th>
<th>Author (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systematic Review</td>
<td>I</td>
<td>1</td>
<td>Rothgangel et al., (2011)</td>
</tr>
</tbody>
</table>
| Randomized Controlled Trials                   | I     | 4              | Michielsen et al., (2011)  
|                                                |       |                | Dohle et al., (2009)      
|                                                |       |                | Yavuzer et al., (2008)    
|                                                |       |                | Sutbeyaz et al., (2007)   |

BEST EVIDENCE
Research by Yavuzer et al. (2008) provided the ‘best’ evidence and was selected for critical appraisal for the following reasons:

- **RCT: highest level of evidence for which statistical analysis was available**
- **Assessor blinded to better control bias**
- **N=40: Largest sample size available**
- **Clearly stated explanation / analysis with fewest number of unanswered questions**

SUMMARY OF BEST EVIDENCE
Table 2: Description and appraisal of Randomized Controlled Trial by Yavuzer et al., (2008), Mirror Therapy Improves Hand Function in Subacute Stroke: A Randomized Controlled Trial.

**Aim/Objective of the Study/Systematic Review:** “To evaluate the effects of mirror therapy on upper-extremity motor recovery, spasticity, and hand-related functioning of inpatients with subacute stroke.” Yavuzer et al. (2008) p. 393.

**Study Design:**
Randomized controlled trial. Assessor-blinded. 4-week trial. Outcomes measured pre/post-treatment and at 6-month follow-up.

**Setting:**
Rehabilitation, education and research hospital in Ankara, Turkey.

**Participants:**
A total of 40 subjects participated (mean age 63.2 years MT, 63.3 years CT). They were all inpatients recruited for rehabilitation for subacute stroke (less than 12 months post-CVA).
Other inclusion criteria:
- Brunnstrom score ranging from I to IV for upper extremity
- Mini-Mental State Examination test score higher than 24 on a 30 point scale
- Ability to comprehend and follow simple instructions.

20 subjects were randomly assigned to either a mirror therapy or control group, performed by a computerized random number generator. At baseline, there were no significant differences between groups in terms of age, time since stroke, gender, side of lesion, R/L dominance, lesion type or baseline scores on Brunnstrom stages, MAS or FIM measures.

All subjects finished the treatment period and none missed more than 1 treatment session. There were 3 patients from the mirror group and 1 from the control group, however, who because of financial limitations, could not participated in the follow-up evaluation 6-months post-treatment.

Intervention Investigated
All participants in the study received conventional therapy (described as physical therapy, occupational therapy and speech therapy, as necessary) 5 days a week, 2-5 hours each day for 4-weeks. All subjects received an additional 30 minutes, 5 days a week, of mirror or “sham” therapy.

Experimental:
Patients in the MT group were seated at a table with a parasagittal mirror, with their affected arm and hand placed behind the mirror. The unaffected upper extremity was reflected into the mirror, creating the visual appearance of both hands performing the same motor movements. A physical therapist led each subject in a series of movements (wrist and finger flexion and extension) while patients watched the reflected image of their unaffected hand. They were also asked to make the same movements with their affected hand to the best of their ability.

Control: Subjects in the control group sat in the same position and performed the same exercises. For this group the mirror was turned to expose the non-reflecting surface, resulting in the paretic hand being hidden from view with no “mirror image” visible.

Outcome Measures:
All assessments were performed by the same investigator. Baseline and post-treatments took place while patients were in rehabilitation. Follow-up assessments (n=17 MT, n=19 CT) were conducted in the outpatient clinic.

- Brunnstrom stages to measure motor recovery (a total of 6 stages, ranging from 1-flaccidity to 6-full range of function)
- Modified Ashworth Scale to measure spasticity of wrist flexor muscles with ordinal rating scale from 0 (no increase in muscle tone) to 4 (“limb rigid in flexion or extension”).
- Functional Independence Measure (6 items in self-care subscore, with individual scores
ranging from 1-“complete dependence” in which the patient performs less than 25% of task, to 7-“complete independence” in which the patient performs 100% of the task. Total score on this subscale can range from 6-42).

Table 1 - Main Findings:
Significant differences were found among the following measures:

<table>
<thead>
<tr>
<th>Brunnstrom stage hand</th>
<th>Mean Value:</th>
<th>Follow-up</th>
<th>Mean change</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value: Baseline</td>
<td>2.6 MT</td>
<td>4.0 MT,</td>
<td>1.4 MT</td>
<td>95% CI</td>
<td>p .001</td>
</tr>
<tr>
<td>2.6 CT</td>
<td>3.1 CT</td>
<td>0.5 CT</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brunnstrom stage UE</th>
<th>Mean Value:</th>
<th>Follow-up</th>
<th>Mean change</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value: Baseline</td>
<td>2.7 MT</td>
<td>4.0 MT,</td>
<td>1.3 MT</td>
<td>95% CI</td>
<td>p .001</td>
</tr>
<tr>
<td>2.7 CT,</td>
<td>3.0 CT</td>
<td>0.3 CT</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIM self-care score</th>
<th>Mean Value:</th>
<th>Follow-up</th>
<th>Mean change</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value: Baseline</td>
<td>23.7 MT</td>
<td>32.0 MT,</td>
<td>8.3 MT</td>
<td>32.0</td>
<td></td>
</tr>
<tr>
<td>21.1CT</td>
<td>22.9 CT</td>
<td>1.8 CT</td>
<td>22.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No significant differences were found in:

<table>
<thead>
<tr>
<th>MAS score</th>
<th>Mean Value: Baseline</th>
<th>Follow-up</th>
<th>Mean change</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Value: Baseline</td>
<td>1.4 MT</td>
<td>1.1 MT</td>
<td>-0.3 MT</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>1.7 CT</td>
<td>1.4 CT</td>
<td>-0.3 MT</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table adapted from Yavuzer et al., (2008)

KEY: MT= Mirror Therapy  CT=Control Therapy

Original Authors’ Conclusions:
In subacute stroke patients who underwent 4-weeks of treatment “mirror therapy in addition to a conventional rehabilitation program was more beneficial in terms of motor recovery and hand-related functioning than a similar treatment without mirroring” (p. 396).

The authors also pointed out that little is known about which patients make the best candidates for mirror therapy, what point during the recovery process is optimal to begin MT or how long the optimal course of treatment should last. They do hypothesize, however, that incorporating MT into the early stages of rehabilitation and employing the technique for a long time frame may provide even greater recovery of motor function.

Critical Assessment

Validity: PEDro score=7/10.
Outcome measures used in this study (Brunnstrom Stages, Modified Ashworth Scale and
Functional Independence Measure) are all well-known, standardized and reliable.

**Methodology:** RCT, with a random sample of participants. Sample size was determined by power calculations aimed at detecting a 20% change in FIM scores between groups. One investigator, who was blinded to the treatment assignments, assessed all patients in the study. Statistical analysis was performed on continuous variables using t-test, on categoric data using chi-square test or Fisher exact test. ANOVAs were used for 2 levels (the different treatment groups) and 3 time frames (baseline, post-treatment and follow-up).

**Interpretation of Results:** Although some of the evidence presented in this CAT is mixed, the weight Level 1 evidence favors mirror therapy, along with conventional therapy, versus conventional therapy alone. These studies, admittedly variable in terms of confidence, demonstrate mirror therapy may be effective in facilitating improved UE motor function in adults with hemiparesis after stroke.

Several limitations of the studies were identified:

- Small sample sizes in each of the identified studies
- Potential selection bias, due to the nature of sampling. Participants who voluntarily participated may have been more motivated to engage actively in therapy (Dohle et al., 2009; Yavuzer et al., 2008; Subeyaz et al., 2007; Michielsen et al., 2010).
- Lack of explanation of “conventional” therapy to which mirror therapy was being compared.
- Lack of consistency / high variability in intervention protocol. Subjects received 2-5 hours of therapy each day, however, there was a lack of explanation regarding differences in duration of daily treatment (Yavuzer et al., 2008; Subeyaz et al., 2007).
- Participants were limited to those with only minor cognitive impairments, despite moderate to severe hemiparesis. The lack of subjects with ataxia and/or visual perceptual deficits may impact generalizability of results (Dohle et al., 2009; Yavuzer et al., 2008; Subeyaz et al., 2007).
- Co-intervention bias must be considered in the studies which also offered conventional therapy in addition to the experimental intervention (Dohle et al., 2009; Yavuzer et al., 2008; Subeyaz et al., 2007).

**Summary/Conclusion:**

The Level 1 evidence presented in this CAT shows patients with upper extremity motor impairments due to stroke may benefit from participation in mirror therapy. Although some of the results were mixed, the preponderance of research shows MT may be effective in improving UE motor recovery and occupational function in both subacute and chronic stroke patients with hemiparesis. There is no evidence regarding the effects of mirror therapy on
clients with moderate-severe cognitive deficits.

Mirror therapy, in contrast to other more time and labor-intensive interventions, is a simple, cost-effective, client-directed intervention. These characteristics make it an attractive option, especially during the current climate of shorter hospital stays, fewer insurance-authorized outpatient visits, and greater emphasis placed on self-directed medical care. Although more research is undoubtedly needed, the current body of evidence provides hope that mirror therapy may provide some clients with stroke greater improvements than current therapies.

### Table 2: Characteristics of included studies

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For stroke: MT + conventional therapy vs. CT alone</td>
<td>Review spanning use of mirror therapy for stroke, phantom limb pain &amp; CRPS.</td>
<td>Mirror therapy on UE. Subjects watched unaffected arm/hand doing motor movements in mirror.</td>
<td>Mirror therapy on LE. Subjects watched unaffected leg doing motor movements in mirror.</td>
<td>Mirror therapy on UE. Chronic stroke subjects watched unaffected arm/hand doing motor movements in mirror.</td>
<td>Mirror therapy on UE. Acute stroke subjects watched unaffected arm/hand doing motor movements in mirror.</td>
</tr>
<tr>
<td>Comparison intervention</td>
<td>MT + conventional therapy vs. CT group which used non-reflective side of mirror. 4-wk + 6-mo follow-up.</td>
<td>MT + conventional therapy vs. CT group which used non-reflective side of mirror. 4-wk + 6-mo follow-up.</td>
<td>MT vs. control group which did the same motor movements, but saw both arms/hands. 6-wk + 6-mo follow-up.</td>
<td>MT vs. control group which did the same motor movements, but saw both arms/hands. 6-wk trial.</td>
<td></td>
</tr>
<tr>
<td>Findings</td>
<td>“Moderate quality” of significant differences</td>
<td>Significant changes in statistically significant</td>
<td>Significant therapy effects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
evidence that MT improves motor function in UE after stroke.
favoring MT group in Brunnstrom stages hand, arm, and FIM scores, which persisted after 6-months. No significant difference on MAS scores.
favor of MT group in Brunnstrom stages LE and FIM self care scores. No significant differences between groups on MAS scores.
improvements in Fugl-Meyer only at post-treatment (did not remain at follow-up). Improvements did not reach clinical relevance of 10%.
found in the MT group on: Fugl-Meyer for subjects who were initially distally plegic; sensory improvement in light touch; improvement in scores of hemineglect.

**Study origin**  
Netherlands  Turkey  Turkey  Netherlands  Germany

**IMPLICATIONS FOR PRACTICE:**
• Each study presented in this CAT provides at least some evidence that patients with motor impairments due to stroke, may benefit from participation in mirror therapy.
• Current evidence addresses only sensorimotor deficits. There is no evidence regarding the effects of mirror therapy on clients with visual-perceptual deficits. There is also no evidence regarding clients with more than mild cognitive deficits.
• Mirror therapy is a low-tech, low-cost option for stroke rehabilitation, which may be done with minimal supervision to complement conventional therapies and enhance positive outcomes.
• The body of research is not yet large enough to inform therapists on who may be the best candidates for mirror therapy, the optimum phase of recovery in which to begin mirror therapy and optimal duration of intervention. This may lead to highly variable methods of delivery.
• Given these limitations, mirror therapy should be presented as an additional option for clients who have suffered stroke.

**IMPLICATIONS FOR EDUCATION:**
• Due to the range of clients who may benefit from mirror therapy, occupational therapy schools should consider including the potential benefits of mirror therapy in course curricula.
• Mirror therapy may also be an intervention worthy of inclusion in the course offerings of other health professions involved in rehabilitation and/or pain management.
• Educational training may also be beneficial for occupational therapists working in home health, as a simple, inexpensive, patient-directed therapy to be done either with, or without therapist supervision.
• Primary care and insurance providers would also benefit from learning more about the research/results on mirror therapy in the treatment for some stroke patients.

**IMPLICATIONS FOR FUTURE RESEARCH:**
Larger scale research is needed on mirror therapy, including studies which focus on:
• Possible improvement of sensory impairments caused by stroke
• Clinical aspects of the intervention (duration of treatment, optimum start time, clients best suited for MT, etc.)
• Comparison of treatment effects between acute, sub-acute and chronic stroke patients
• Comparison of treatment effects between patients with damage to left/right, dominant/non-dominant hemispheres
• Comparison of treatment effects between patients with/without visual-perceptual deficits, spatial neglect, ataxia, lower cognitive levels
• Effectiveness of mirror therapy as part of a home program
• Neurological mechanism by which mirror therapy appears to work
• Functional Magnetic Resonance Imaging (fMRI) research on possible cortical reorganization

REFERENCES


