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MIRROR THERAPY AND PHANTOM LIMB PAIN AN EVIDENCE BASED REVIEW



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Problem and Significance

- Phantom limb sensations and pain are a possible consequence of limb amputation
- Average of 133,235 limb-loss related discharges from acute hospitals per year (data between 1988-1996 in the U.S.) (Dillingham 2002)
- Amputation due to vascular conditions accounted for 82%, trauma 16.4%, and cancer and congenital conditions for 1.6% (Dillingham 2002)

Problem and Significance

- Studies have reported rates of occurrence for post-amputation phantom limb pain (PLP) of 53-100% (Ephraim 2005, Richardson 2006)
- 39% report episodes of severe pain (Ephraim 2005)
- Up to 79% of those with PLP continue to experience symptoms six months after amputation (Richardson 2006)

Problem and Significance

- Difficult to identify risk factors associated with development of PLP
 - Pre-amputation pain intensity and passive coping styles positively associated with PLP (Richardson 2007)
- Variety of pharmacological and surgical treatments have been studied
- Results are inconsistent (Halbert 2002)

Primary Question

- Is mirror therapy a more effective strategy than other physical therapy interventions for the treatment of phantom limb pain?
- PICO
 - Patients: Subjects with upper or lower extremity amputations
 - Intervention: Mirror therapy
 - Control: Various treatments appropriate to physical therapy
 - Outcomes: Pain assessment

Background:

Pain Following Amputation

⦿ Residual limb pain

- Mediated by peripheral sources: adherent scars, neuromas, wound infection
- Nociceptive pain

⦿ Phantom Limb Pain

- Perceived in part of limb no longer existing
- Considered multi-factorial – peripheral and central sources
- Neuropathic pain

Background: Treatment

- Medical management
 - Amputation revision or neuroma excision
 - Wide variety of medications
 - Peripheral nerve blocks
 - Dorsal root rhizotomy
 - Spinal cord or deep brain stimulation device

Background: Treatment

- ⦿ Physical therapy intervention
 - Address factors contributing to residual limb pain (i.e. scar mobilization, soft tissue mobilization, joint range of motion, muscle strength)
 - Prosthetic fitting and use
 - Modalities
 - No standard treatment

Background: Treatment

- Novel or alternative approaches
 - Acupuncture
 - Hypnosis
 - Biofeedback
 - TENS
 - Sensory discrimination
 - Mirror therapy
 - Computer virtual limb therapy

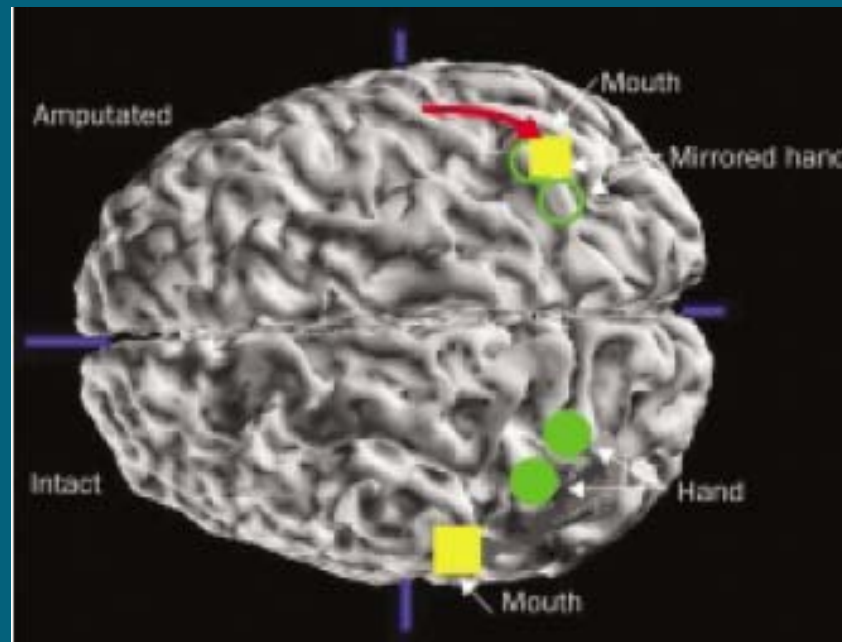
Background: Phantom Limb Pain Sources

○ Neuropathic Pain

- Dysfunction at the level of the peripheral nervous system
 - Peripheral sensitization and wind-up
- Changes at the central nervous system
 - Central sensitization
 - Cortical reorganization

Theoretical Construct

- Cortical re-organization is process of neural plasticity that involves changes to the mapping in the primary sensory cortex



Theoretical Construct

○ Cortical Reorganization

- Studies have shown changes in somatosensory cortical mapping with various pain syndromes (Accera 2007, Juottonen 2002)
- Studies have shown a positive correlation between PLP and the amount of cortical reorganization (Flor 1998, Grusser 2001, Karl 2001)

Theoretical Construct

- Referred sensations in the phantom limb are the perceptual correlate of this reorganizational process (Ramachandran 1992)
- Mirror therapy has demonstrated effectiveness in patients with CRPS and post-stroke pain (McCabe 2003, Sathian 2000, Acerra 2007)

Mirror Therapy



- Visualization of missing limb using mirror
- Originally described by Dr. Ramachandran



Null and Alternate Hypothesis

- Is mirror therapy a more effective strategy than other physical therapy interventions for the treatment of phantom limb pain?
 - Null Hypothesis: There is no difference in effect on phantom limb pain between mirror therapy and other treatment methods
 - Alternate Hypothesis: There is a different in effect on phantom limb pain between mirror therapy and other treatment methods

Expected Findings

- ⦿ There is little research evidence to support physical therapy interventions for PLP
- ⦿ Most research is directed at medical management
- ⦿ Mirror therapy would be more effective than other treatments

Search Methods

⦿ Sources

- PubMed
- CINHAL
- Cochrane
- PEDro

⦿ Key Words

- Phantom Limb Pain
- Neuropathic Pain
- Mirror therapy
- Treatment

Inclusion Criteria

- Articles used to answer the primary question had the following inclusion criteria
 - Human subjects with upper or lower extremity amputation
 - Presence of phantom limb pain at time of treatment
 - Utilize a treatment that is reproducible in the context of physical therapy
 - Outcome measure that included pain assessment

Articles for Primary Question

- Total of 11 articles related to primary question
- 6 of the articles met the inclusion criteria
- All the articles were independently evaluated by a second reviewer

Brodie, et al. 2006	RCT Level 2b	Mirror therapy group, control group with mirror covered
Chan et al. 2007	RCT Level 2b	Mirror therapy group, control group with mirror covered or mental visualization
Moseley 2006	RCT Level 2b	Motor imagery group, control group with medical and PT management
Flor et al. 2001	RCT Level 2b	Sensory discrimination training, control group with medical and PT management
Katz et al. 1991	Cross over Level 2b	Auricular TENS group, control group with sham TENS
Kawamura et al. 1997	Case series Level 4	TENS stimulation to intact limb

Mirror Therapy Studies

- Total of three studies included to answer primary question
- All used mirror box treatment of similar construction
- One had additional treatments as part of “graded motor imagery” program
- Various control groups

	Brodie et al. 2006	Chan et al. 2007
Mirror therapy treatment group protocol	10 movements 10x each for one session	15 minutes per day for 4 weeks
Comparison group	Performed same movements with mirror covered	Group 1: same treatment with mirror covered Group 2: 15 minutes of mental visualization
Number of subjects	Total 15	Total 18
Outcome measure	MPQ and pain VAS	Pain VAS
Findings	Significant decrease in MPQ (F=7.195, p<.05)	Significant decrease in VAS (no F score reported)

Moseley 2006

- Effects of “graded motor imagery” program on patients with CRPS1 and PLP (9 subjects)
- Treatment group: 2 weeks each of following
 - Limb laterality recognition
 - Imagined movements
 - Mirror therapy
- Control group: physical therapy and medical management

Moseley 2006

- Outcomes: VAS
- Subjects with CRPS and PLP analyzed as a group
- Significant decrease in VAS score for treatment group ($F = 6.77, p < .001$)

Other Treatment Studies

- 3 articles reported on other types of treatments for PLP
 - 2 used TENS, applied in different manners
 - 1 used sensory discrimination training with electric stimulation

	Katz et al. 1991	Kawamura et al. 1997
TENS treatment protocol	TENS applied to bilateral ears for 10 minutes, one session	TENS to residual or contra-lateral limb for 30 minutes, 3x day, for average of 9 weeks
Comparison Group	Sham TENS	Case series, no control group
Number of subjects	Total 11	Total 10
Outcome measures	MPQ	VAS
Findings	Significant decrease in MPQ score (F=7.09, p<.01)	Decrease in VAS Not able to assess significance

Flor 2001

- Sensory discrimination training
- 10 subjects
 - Treatment group: feedback guided sensory discrimination training with surface electrodes, ten 90-minute sessions over 2 weeks
 - Control group: PT and medical management
- Outcomes: West Haven-Yale Multidimensional Pain Inventory
- Treatment group had significant decrease ($t=3.27$, $p<.008$)

Results: Number Needed to Treat

Article	NNT (95% CI)	Improvement	Treatment	Control
Chan et al.	2 (1-2)	Decrease in VAS score	Mirror therapy	Covered mirror
Chan et al.	2 (1-4)	Decrease in VAS score	Mirror therapy	Mental visualization
Brodie et al.	4 (2-infinite)	No PLP	Mirror therapy	Covered mirror
Flor et al.	2 (1-6)	Decrease in MPI score	Sensory discrimination	Medical and PT
Katz et al.	4 (2-infinite)	Decrease MPQ >33%	Auricular TENS	Sham TENS

Effect Size

Brodie et al. (VAS score)

- Mirror therapy

Brodie et al. (MPQ score)

- Mirror Therapy

Moseley (VAS score)

- Motor Imagery program

Flor et al. (MPI score)

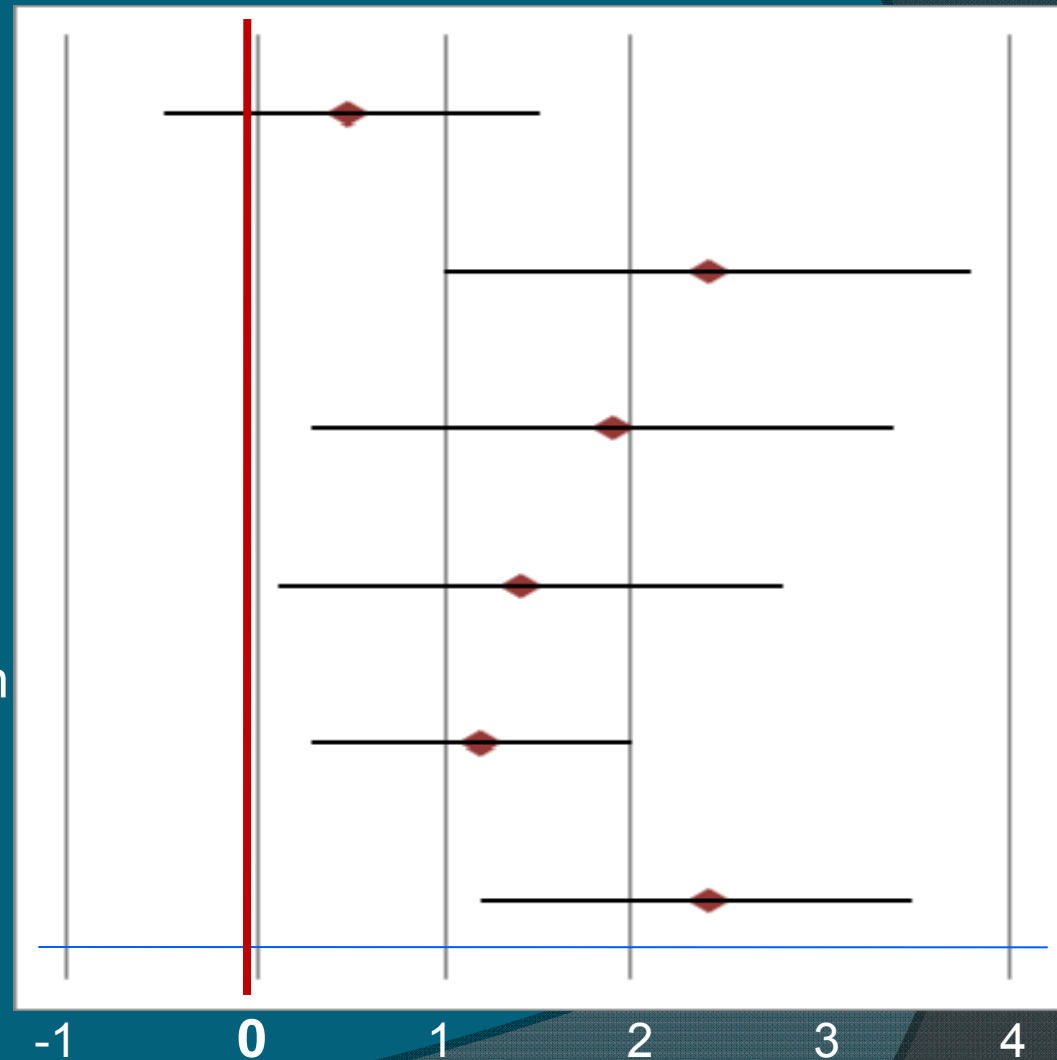
- Sensory discrimination

Katz et al. (MPQ score)

- Auricular TENS

Kawamura et al. (MPQ)

- TENS



Discussion

- Null Hypothesis: There is no difference in effect on phantom limb pain between mirror therapy and other treatment methods
- Not able to reject null hypothesis
 - Mirror therapy does not appear to be more effective than TENS or sensory discrimination training

Clinical Significance

- All studies reported significant results
- NNT and Effect Size for these studies show good results for all treatments
- No report of harm to patients through use (i.e. no increase in PLP)

Limitations

- Different methods used to assess pain across studies
- Various treatments used as comparison group
- Different amounts of treatment
 - One 10-minute session to 6 week course of daily therapy
- Large Confidence Intervals
 - Small sample sizes
 - Large variation in outcome measures

Conclusions

- Mirror therapy, TENS and sensory discrimination demonstrated moderate to large effect sizes and small NNT
- Cannot reject null hypothesis
- Level of evidence is not adequate to provide clinical guidelines for the use of these treatments

Future Research

- Studies with larger numbers of subjects
- Studies which evaluate effectiveness of physical therapy treatment of PLP
- Compare mirror therapy, sensory discrimination and TENS to well described conventional physical therapy treatment protocol

Thank you

Diane Allen PT, PhD

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Classmates of the past three years



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