

Effectiveness of Mirror Therapy on Phantom Limb Pain in patients with Below Knee Amputation

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ABSTRACT

Background: When a limb is severed or its sensory roots are destroyed, it is typical to experience the phenomena of a phantom limb. PLP frequently affects patient's quality of life and increases the limitations caused by amputation, potentially compromising social or professional reintegration. Mirror therapy has not gained widespread use for unilateral below-knee amputation, despite early interest in treating phantom limb pain. Aim of this research is to see the effectiveness of mirror therapy on phantom limb pain in patients with below knee amputation.

Methods: 49 individuals who had undergone a unilateral below-knee amputation were split into two groups at random: Group A underwent mirror therapy in addition to conventional therapy, while Group B only received conventional therapy. For three weeks, both groups attended intervention sessions five days a week. The SF36 health survey, the visual analogue scale (VAS), and the brief pain inventory (BPI) were among the outcome measures. Scores before and after the intervention were noted and compared between groups.

Result: In comparison to Group B, Group A showed larger numerical decreases in pain intensity (VAS); nevertheless, this difference was not statistically significant ($P > 0.05$). Significant gains in Group A's SF36 Physical and Mental Health ratings were noted ($P < 0.05$), suggesting that mirror therapy improved quality of life. Group-to-group variations in BPI scores were similar.

Conclusion: These findings support the integration of mirror therapy into conventional rehabilitation programs for amputees, particularly to improve quality of life and functional recovery. Further studies with larger samples and long-term follow-up are warranted to confirm these outcomes

Keywords: Mirror therapy, Phantom limb pain, Amputation, below knee amputation

1. INTRODUCTION

The phenomenon of a phantom limb is a common experience after a limb has been amputated or its sensory roots have been destroyed.¹ Phantom limb pain (PLP) after a major limb amputation can have devastating consequences. This condition carries a significant physical, psychological, and economic burden.² Surgical and pharmacological modalities such as preoperative, and immediate postoperative analgesia,^{3,4,5} acetaminophen and nonsteroidal anti-inflammatory drugs,⁶ opioids,⁷ antidepressants, anticonvulsants, and other medications have been used to relieve PLP.⁸ Non-pharmacological approaches, such as transcutaneous electrical nerve stimulation (TENS), virtual reality therapy, and graded motor imagery, are gaining prominence for their ability to address the root causes of PLP without adverse effects.⁹ Among these, mirror therapy (MT) has emerged as a promising and innovative intervention. Developed by Dr. V.S. Ramachandran in the 1990s, MT is based on the concept of visual feedback. By using a mirror to reflect the image of the intact limb, it creates the illusion of the amputated limb being present and functional. This visual trick engages the brain's motor and sensory networks, promoting cortical reorganization and reducing pain. MT may work by replacing maladaptive neural connections with more adaptive patterns, thereby addressing the primary cause of PLP.¹⁰ Its simplicity, affordability, and non-invasive nature make it a practical choice, especially in low-resource settings where access to advanced rehabilitation technologies may be limited. The outcomes of MT can vary widely depending on factors such as the patient's psychological state, the duration of therapy, and the extent of cortical reorganization. These challenges highlight the need for individualized therapy plans and further research to optimize its application. Previous evidences indicated that an external object can be more easily integrated into

one's own body representation if there is a high degree of congruence between sensory modalities¹² The activation of mirror neurons in the hemisphere of the brain opposite the amputated leg may be the cause of the pain alleviation linked to mirror treatment.¹³ Mirror therapy reduced the incidence of phantom limb pain when administered pre-emptively in patients undergoing amputation surgeries.¹⁴ That's why the technique of mirror therapy box requires the patient to remain with head facing the mirror in a relatively fixed position and the body in medial sagittal plane with respect to mirror, then the has to ignore the intact limb and focusing on the reflecting image of phantom limb. And the movements of intact limb which are reflected in mirror mimics the movements of phantom limb which helps to reduce phantom limb pain. So the aim of this study is to evaluate the effectiveness of mirror therapy on phantom limb pain in patients with below knee amputation

2. METHODS

The comparative experimental study was held with pre-post intervention design to assess the effectiveness of mirror therapy in reducing phantom limb pain and improving quality of life in patients with below knee amputation in Krishna hospital, karad in Maharashtra. After getting clearance from ethical committee 49 participants were enrolled in this study by using below mentioned sample size formula;

$$n = (z)^2(pq)/(L)^2.$$

The 49 participants were included in a criteria which includes adults aged above 18 years, diagnosed with unilateral below knee amputation experiencing phantom limb pain for at least three months. And participants with opioid medication and any other neurological or psychiatric disorders were excluded in this study. These participants underwent a three week intervention, with five session per week, each lasting for 20 to 30 minutes. Visual analogue scale(VAS), brief pain inventory(BPI) and SF36 questionnaire (differentiating physical health and mental health) were included in outcome measures.

A mirror box sized of 2.5ft used for this study that provided visual illusion of missing limb. Allocation of participants were done in two groups: Group A -mirror therapy with conventional therapy and Group B - conventional therapy. First of all, Pre assessment of each patient was done by taking demographic data, visual analogue scale(VAS), brief pain inventory(BPI) and SF36 questionnaire (differentiating physical health and mental health) of the patients.

Intervention protocol:

For three weeks in a row, both groups received therapy five days a week for a total of 15 sessions.

- Mobility training, strengthening exercises, stretching, and residual limb care were all part of conventional therapy.
- A mirror box positioned midline was used for mirror therapy sessions. While looking at their mirror reflection, the patient made symmetrical motions with their intact limb to provide the appearance of movement in the missing limb. Each session lasted roughly twenty to thirty minutes. After entering all the required data into an Excel sheet, the data was analyzed using Instat software, and the results were computed.

3. RESULTS

The present study evaluated the effectiveness of mirror therapy combined with conventional therapy compared to conventional therapy alone in patients with phantom limb pain.

Visual analogue scale (VAS)	Pre	Post
Group A	7.8 ± 1.0	5.5 ± 1.3
Group B	7.9 ± 1.1	5.7 ± 1.4
P value	0.74	0.68
Inference	Not significant	Not significant

Table no.1: VAS scores.

Interpretation: Both groups showed a reduction in pain, but the difference between them is statistically not significant.

Brief pain inventory (pain severity score)	Pre	Post
Group A	6.5 ± 1.2	4.4 ± 1.1
Group B	6.6 ± 1.3	4.5 ± 1.2
P value	0.69	0.72
Inference	Not significant	Not significant

Table no.2: Brief Pain inventory scores pain severity scores

Interpretation: Both groups improved in terms of pain severity but the difference between them is not statistically significant.

Brief pain inventory (pain interference score)	Pre	Post
Group A	6.8 ± 1.1	5.4 ± 1.2
Group B	7.0 ± 1.0	5.3 ± 1.3
P value	0.62	0.77
Inference	Not significant	Not significant

Table no.3: Brief pain inventory pain interference score

Interpretation: Both groups had a reduction in pain interference, but there is no statistical difference between them.

SF 36 survey (Physical health)	Pre	Post
Group A	35.2 ± 5.3	44.7 ± 6.2
Group B	34.8 ± 5.6	41.5 ± 5.8
P value	0.66	0.04
Inference	Significant	Significant

Table no.4: SF 36 survey- Physical health scores

Interpretation: While pre- treatment scores were similar, post-treatment scores show a statistically significant improvement in group A's physical health compared to group B.

SF 36 survey (Mental Health)	Pre	Post
Group A	40.3 ± 6.5	49.7 ± 5.8
Group B	41.2 ± 6.2	48.9 ± 6.0
P value	0.58	0.49
Inference	Significant	Significant

Table no.5: SF 36 survey Mental Health scores

Interpretation: Both groups experienced significant improvement in mental health.

4. DISCUSSION

Phantom limb pain (PLP) continues to be one of the most difficult complications following amputation, significantly affecting functional recovery, mental well-being, and overall life quality. The current research examined the effectiveness of mirror therapy combined with conventional physiotherapy, comparing it to conventional therapy alone in individuals with unilateral below-knee amputation suffering from PLP. The findings suggest that while both treatment methods resulted in reduction in pain intensity and improvements in quality of life, the group receiving mirror therapy exhibited more pronounced benefits, especially regarding physical and mental health. A key finding of this research was the alteration in Visual Analogue Scale (VAS) scores, which indicate the patient's personal perception of pain severity. While the reduction in VAS scores for the mirror therapy group was more pronounced than that of the conventional group, the difference was not statistically significant. This may be due to the brief intervention duration of three weeks or the limited number of participants. The observed pattern still aligns with earlier studies indicating that mirror therapy may have a beneficial effect on pain modulation by delivering corrective visual feedback to the brain, which could potentially change the maladaptive cortical representations linked to phantom limb pain (PLP). The concept behind mirror therapy is rooted in neuroplasticity. Mirror therapy seeks to alter or counteract these cortical changes by creating the illusion that the amputated limb is functioning normally. This visual stimulation triggers mirror neurons and reactivates motor-sensory pathways, potentially normalizing the activity in the impacted cortical regions. In addition to assessing pain intensity, this research examined pain-related interference and severity through the Brief Pain Inventory (BPI). These findings align with prior research suggesting that mirror therapy may reduce pain severity by allowing the brain to reinterpret visual and proprioceptive signals more effectively. The most notable and statistically significant results were found in the SF-36 physical and mental component scores. These findings underscore the broader impact of mirror therapy beyond pain reduction alone. Improvements in the SF-36 physical health score suggest that participants in the mirror therapy group experienced better physical function, possibly due to increased engagement in movement and improved perception of body image. Physical improvements may also stem from increased cortical activation of motor areas during mirror therapy sessions, enhancing neuromuscular coordination of the residual limb. The SF-36 mental health score also showed statistically significant improvements in the mirror therapy group. This is particularly relevant because PLP is closely associated with emotional distress, anxiety, depression, and a sense of bodily disintegration. The visual and psychological experience provided by mirror therapy may contribute to a more cohesive body image and a reduced sense of loss. In addition, the act of watching the "phantom" limb move can be a powerful psychological reinforcement that helps patients feel more whole and less disabled. Although pain relief is often the primary goal of intervention, improving the patient's quality of life is equally important in post-amputation care. Mirror therapy, by targeting both pain perception and psychological integration, offers a unique dual benefit.

Another important aspect of this study is the accessibility and cost-effectiveness of mirror therapy. Unlike pharmacological treatments or invasive procedures, mirror therapy is simple, safe, and inexpensive. It does not require high-tech equipment or prolonged rehabilitation time. This makes it particularly suitable for use in resource-limited settings or for home-based rehabilitation programs. Given the rising number of amputations worldwide due to trauma, diabetes, and vascular disease, especially in developing countries, the inclusion of such low-cost yet effective interventions could have a broad public health impact. The study ensured random allocation, the lack of blinding may have introduced performance bias, especially in subjective measures like VAS and SF-36. Participants in the mirror therapy group may have had higher expectations due to the novelty of the intervention, potentially influencing their self-reported outcomes. However, the use of validated, widely accepted outcome measures and the consistency of the observed trends across variables reinforce the credibility of the findings. In clinical practice, these findings suggest that mirror therapy can be a valuable adjunct to standard physiotherapy in the management of phantom limb pain. Its ability to improve both physical function and mental health enhances its appeal as a holistic intervention. Clinicians should consider incorporating mirror therapy into their rehabilitation protocols, especially for patients struggling with chronic PLP and associated psychological challenges. To conclude, this study adds to the growing body of evidence supporting the role of mirror therapy in PLP management. While the pain relief effects may vary depending on individual's responses, the significant gains in functional and mental health outcomes indicate that mirror therapy holds promise as a comprehensive tool in amputee rehabilitation. Further research should explore optimal treatment durations, mechanisms of action, and long-term effectiveness for the betterment of research.

5. CONCLUSION

The present study demonstrated that both mirror therapy and conventional therapy led to improvements in pain intensity, functional capacity, and quality of life in individuals with phantom limb pain following lower limb amputation. While the reduction in pain measured by the Visual Analogue Scale (VAS) was not statistically significant between groups, patients receiving mirror therapy exhibited a greater numerical improvement. More importantly, significant improvements were observed in the physical and mental components of the SF-36 health questionnaire, indicating that mirror therapy offers additional benefits in enhancing overall well-being.

These findings support the integration of mirror therapy into conventional rehabilitation programs for amputees, particularly

to improve quality of life and functional recovery. Further studies with larger samples and long-term follow-up are warranted to confirm these outcomes

REFERENCES

- [1] Melzack R. Phantom limbs and the concept of a neuromatrix. *Trends Neurosci.* 1990 Mar;13(3):88-92. doi: 10.1016/0166-2236(90)90179-e. PMID: 1691874.
- [2] Chong DST, Pople M, Hardy TJ, Cowan A, Birchley D, Guy A, McCarthy R, Welchman SA. Mirror Therapy for the Mpanagement of Phantom Limb Pain: A Single- Center Experience. *Ann Vasc Surg.* 2023 Sep;95:184-187. doi: 10.1016/j.avsg.2023.03.033. Epub 2023 Apr 17. PMID: 37075833.
- [3] Reuben SS, Buvanendran A. Preventing the development of chronic pain after orthopaedic surgery with preventive multimodal analgesic techniques. *JBJS.* 2007 Jun 1;89(6):1343-58.DOI: 10.2106/JBJS.F.00906.
- [4] Wilson JA, Nimmo AF, Fleetwood-Walker SM, Colvin LA. A randomised double blind trial of the effect of pre-emptive epidural ketamine on persistent pain after lower limb amputation. *PAIN®.* 2008 Mar 1;135(1-2):108-18 DOI: 10.1016/j.pain.2007.05.011
- [5] Karanikolas M, Aretha D, Tsolakis I, Monantera G, Kiekkas P, Papadoulas S, Swarm RA, Filos KS. Optimized perioperative analgesia reduces chronic phantom limb pain intensity, prevalence, and frequency. *Anesthesiology.* 2011 May;114(5):1144-54.DOI: 10.1097/ALN.0b013e31820fc7d2
- [6] Hanling SR, Wallace SC, Hollenbeck KJ, Belnap BD, Tulis MR. Preamputation mirror therapy may prevent development of phantom limb pain: a case series. *Anesthesia& Analgesia* 2010 Feb 1;110(2):611-4.DOI: 10.1213/ANE.0b013e3181b845b0
- [7] Nathanson M. Phantom limbs as reported by S. Weir Mitchell. *Neurology.* 1988 Mar;38(3):504-.doi: 10.1212/wnl.38.3.504.
- [8] Casale R, Alaa L, Mallick M, Ring H. Phantom limb related phenomena and their rehabilitation after lower limb amputation. *European journal of physical and rehabilitation medicine.* 2009 Feb 26;45(4):559-66.
- [9] Tilak M, Isaac SA, Fletcher J, Vasanthan LT, Subbaiah RS, Babu A, Bhide R, Tharion G. Mirror Therapy and Transcutaneous Electrical Nerve Stimulation for Management of Phantom Limb Pain in Amputees - A Single Blinded Randomized Controlled Trial. *Physiother Res Int.* 2016 Jun;21(2):109-15. doi: 10.1002/pri.1626. Epub 2015 Apr 1. PMID: 25832306.
- [10] Collins KL, Russell HG, Schumacher PJ, Robinson-Freeman KE, O'Connor EC, Gibney KD, Yambem O, Dykes RW, Waters RS, Tsao JW. A review of current theories and treatments for phantom limb pain. *J Clin Invest.* 2018 Jun 1;128(6):2168-2176. doi: 10.1172/JCI94003. Epub 2018 Jun 1. PMID: 29856366; PMCID: PMC5983333.
- [11] Tsakiris M. My body in the brain: a neurocognitive model of body-ownership. *Neuropsychologia.* 2010 Feb;48(3):703-12. doi: 10.1016/j.neuropsychologia.2009.09.034. Epub 2009 Oct 9. PMID: 19819247.
- [12] Eck J, Pfister R. Bound by Experience: Updating the Body Representation When Using Virtual Objects. *Human Factors.* 2025 Feb;67(2):115-40.
- [13] Chan BL, Witt R, Charrow AP, Magee A, Howard R, Pasquina PF, Heilman KM, Tsao JW. Mirror therapy for phantom limb pain. *New England Journal of Medicine.* 2007 Nov 22;357(21):2206-7.
- [14] Purushothaman S, Kundra P, Senthilnathan M, Sistla SC, Kumar S. Assessment of efficiency of mirror therapy in preventing phantom limb pain in patients undergoing below-knee amputation surgery—a randomized clinical trial. *Journal of Anesthesia.* 2023 Jun;37(3):387-93..