Case Reports in Clinical Medicine, 2022, 11, 273-279
https://www.scirp.org/journal/crcm
ISSN Online: 2325-7083
ISSN Print: 2325-7075

Motor Response of Mirror Therapy after Reconstruction of Extensor Mechanism Caused by Glass Cut Injury

Maha Farhina

Plastic Surgery Department, Dr. Ruth K. M Pfau Civil Hospital Karachi, Karachi, Pakistan
Email: mahafarhina24@gmail.com

How to cite this paper: Farhina, M. (2022) Motor Response of Mirror Therapy after Reconstruction of Extensor Mechanism Caused by Glass Cut Injury. *Case Reports in Clinical Medicine*, **11**, 273-279.
https://doi.org/10.4236/crcm.2022.118040

Received: July 10, 2022
Accepted: August 1, 2022
Published: August 4, 2022

Abstract

Treatment by mirror therapy (MT) restores motion in injured limbs without invasive procedures. This process is widely accepted for rehabilitating patients with phantom limb pain, stroke victims, or patients who need therapy after nerve damage. The procedure is specifically useful in restoring motion to the hand after surgical repairs to the extensor muscle and tendons. Mirror therapy rewires the brain by making the restored limb remember hand motions by observing the motions of a normal hand. The concept of a mirror image is that the movement of the uninjured arm forms the illusion of the same movement in the affected arm. Efforts to repeat hand movements elicit the same reaction in the affected hand in what is referred to as Hebbian learning. This case study evaluated MT's effectiveness in motion restoration after a glass injury. This case study showed restoration of normal hand motions in a patient following surgery to repair a glass cut to the arm. Surgery repaired the lacerated extensor tendon and radial nerve. The muscle belly was repaired, and a graft fixed the nerve gap. Once the arm healed, the patient underwent rehabilitation in mirror therapy to restore normal function in his hand. After conducting mirror therapy, the pain was eliminated, and the patient restored normal function of moving the hand and finger extension. In addition, the therapy could be conducted at home without needing a professional. The effectiveness of mirror therapy was seen in the functional restoration of hand and finger movement. The process is also less complicated as it can be performed at home.

Keywords

Mirror Therapy, Glass Cut Injury, Neuro-Musculoskeletal, Extensor Tendon Injury, Extensor Muscles

1. Introduction

The extensor mechanisms of the human arm and wrist are anatomically complex. Extensor and flexor tendons are important in straightening the wrist, digits, and thumb. These tendons are attached to arm muscles. Injury to extensor muscles and tendons can make it difficult to straighten joints. The most common cause of loss of extensor muscle functioning is radial nerve disruptions. Because the patient with this circumstance cannot open the hand to grip objects, the transmission of properly functioning muscle-tendon components is frequently used to compensate for the deficit. The wrist extensors, as well as finger extensors, along with the thumb, are supplied by the radial nerve. Damage to the extensor tendon can be repaired in the emergency department while a surgeon in an operating room repairs other. After the surgical restoration of the extensor tendons, establishing a particular rehabilitation regimen takes into account the extent of the injury, the effectiveness of the repair, the difficulty of the treatment protocol, and the client's expected conformance with therapy. Each patient presents unique complexities; thus, choosing the therapy that best restores normal hand extensions, such as mirror therapy, is important. Besides other rehabilitation procedures such as electrical muscle stimulation and electromechanical training, mirror therapy has many potential benefits [1].

Mirror Therapy is essential in the eventual management of motor response after surgery. The procedure is based on "visual stimulation" where a mirror is placed in the midsagittal plane to reflect the non-affected side as if it was the affected hand [1]. The mirror's function is to reflect actions of the less affected arm as if it was the injured one. As a result, their affected hand is tricked into regaining its motor skills. Each session lasts for around thirty minutes and the therapy can take from 8 weeks to six months [2]. Mirror therapy is a common rehabilitative procedure used in extensor tendon injury patients to recover motor function as well as the ability to participate in daily activities. Mirror therapy, therefore, helps the patient reorient their brain sensation in case of a missing arm so that they no longer feel pain in the affected limb. The procedure is simple but requires a qualified therapist to establish a routine. Mirror therapy uses a mirror box. A mirror box is just a box that does not have a lid. A 2-sided mirror is located in the center of the container. The box's side contains two punched holes to let the client insert the injured arm and the undamaged one. The patient then looks over the edge of the box from an angle and moves the good arm, while imagining that the "motion was produced by the paretic extremity" [3]. This way the patient can move their paretic arm in similar fashion. Within the mirror, the uninjured arm is mirrored and seen. Through this setup, the motions of the injured arm cause an illusion of the normal arm [1]. When the normal arm moves, the brain sends signals for the arm to remember motions. Indeed, studies show that observing motions and performing the same tasks share common cortical motor parts [1]. Throughout therapy, the mirror arm is considered to be operating by deceiving the brain into surpassing uncomfortable sensations in the patient. This action was predicated on the notion that whenever the patient sought to adjust the posture of the affected limb, the arm could not move due to proprioception and eyesight. Efforts to produce similar movements repeatedly elicited the same reaction, a process known as Hebbian learning.

Due to nerve damage, hand muscles cannot grasp objects. Mirror therapy rehabilitates the extensor muscles and tendons for the hand to function normally. Research has determined through ongoing monitoring that mirror treatment modifies the cortical architecture in the central nervous system when used [4]. This reorganization is responsible for the relief of pain and restoring hand motion. This treatment is frequently therapist-guided to track progress and reduce mishaps. Progress in therapy is due to the precise exercises required while undergoing the therapy. Nonetheless, therapists gave the treatment the go-ahead to be performed at home, because it only requires a mirror and perseverance to attain the desired results. Contrary to other therapies which need somatosensory input to perform, MT is basically visual; thus, it can be self-performed at home [1]. Thus, the procedure is easily manageable and convenient for the patient.

Causes of limb pain are also essential to investigate to understand why mirror therapy is recommended as an effective treatment. MT strategies' purpose is to restore the performance of practical tasks [1]. Theme *et al.* argue that even though vision is essential in directing movement among people with visual perception, more is at stake in this case. Proprioception, or the sensation of the motion and location of body parts, sends signals to the cerebral cortex as the arms move. Neural pathways that control limb mobility are interfered with following nerve damage. The neural signals that carry sight and proprioception are likewise unaffected.

Adults who suffer extensor muscle and tendon following a glass cut accident can benefit from mirror therapy to better their motor function. The procedure puts the mirror in the injured person's midsagittal plane. The method's success improves motor dysfunction and motor control after an injury compared to placebo, mock therapy, or other therapies. The overarching focus is whether Mirror Therapy improves mobility, lack of focus on pain, everyday activity effectiveness, and awareness of the impaired range of view after a glass cut injury. Mirror treatment has recently gained popularity, with claims of a rising number of PLP patients showing "significant benefit" [5] p. 2. The approach, also referred to as mirrored visual feedback (MVF), has proven beneficial in various conditions, including brain stroke and complicated localized pain syndrome [6]. Because mirror therapy depends on visual inputs, it is attainable, and some forms of stimuli, such as aural feedback, could help with motor skills in the wrist and hands. We present a case of a severed extensor muscle and radial nerve damage patient, attended with mirror treatment and voiced feedback after being involved in a glass cut accident. In the following case, mirror therapy was used to rehabilitate the injured arm and see if the hand was properly functioning.

2. Presentation of a Case

This case report is based on a patient whose arm suffered severe muscular and nerve damage after the partially severed glass. A male patient with a deep traumatic laceration of the hand on the orthodosal side caused by a glass cut presented to the emergency unit after clinical examination, a complete transverse transection of his arm's extensor muscle ECRB, ECRL, and EDC of all fingers was identified. The laceration on the muscles was fully repaired through surgery using klesser technique. The patient had severe muscle on the forearm in a glass cutter. The cut had also severed the nerve and muscle in the arm. The surgical team repaired the muscle belly using several suture techniques. The nerves also were completely lacerated, leaving a gap, so they needed repairing too. The surgical team put a nerve graft in the arm to compensate for the gap. After the surgery, the muscle belly was transfected.

The patient endured therapy in surgery, whereby surgical treatment included nerve and tendon repair, before being moved to the acute recuperation center. The arm, following the reset, performed well, and the patient could extend his fingers and experience less pain. The patients used several drugs to promote healing and manage pain. In the weeks following healing, it was proposed that mirror therapy could assist in determining normal hand and finger motion. With him sitting on a chair, a vertically mounted mirror in a frame was made for simple placing along his centerline chest. Leaning slightly over, he could see the reflection of his left arm when he performed simple range of motion of hand. The sessions were held six days a week and initially lasted for thirty minutes which included ten minutes of M.T 5reps with one-minute resting. The rest of the session involved Transcutaneous Electric Nerve stimulation and hot therapy, and later on basis of improvement the exercises was advanced to dumbbell curls, grip opening and shutting, pronating and supinating the extended "limbs", all while striving to focus on completing these motions simultaneously. He was placed into more aggressive therapy lasting up to these moves for 20 minutes at a time, twice every day.

The therapy affirmed that the patient maintained normal motor function of his fingers and hand extension. Apart from gabapentin, all pain medicines were progressively tapered off over the seven days of MT. A dosage of Gabapentin was reduced to 200 mg once times daily. After three days of mirror therapy, his pain dropped, and his hand function improved. He took lisinopril 10 mg every day at the end of twenty-one days. At the start of the therapy, the patient needed a professional to assist with the therapy.

In the beginning, this procedure might be performed under the supervision of a qualified therapist. As soon as the therapist is convinced that the client can continue with the therapy on their own, they can let them go. The therapy provided professional monitoring in the initial stages of the process. Because the technique is classified as easy, the patient required little professional monitoring. Because the treatment does not need any extra special tools to be successful, it can be performed on the lower extremities and upper arms [5]. I focused on therapy on the restored arm and alleviating the patient's pain. I modified all the following procedures to meet the patient's amputated location. As a result, it was clear that this therapy was providing pain relief to my patient. Nevertheless, with enough practice, the patient could carry on the procedure independently or with assistance from his mother, who was his at-home caregiver.

Indeed, even during the treatment period, another attendant took part by clapping their hands in time with the motion of his arms to the mirror, creating the impression of both seeing and listening to the hand clapping. This type of aural input was promoted and extended during his acute recovery. Whereas MVF was initially invented to restore the patient's nerve function, auditory stimulation was conducted concurrently with mirror therapy. His other recovery milestones were completed quicker than anticipated, and he was approved for discharge to go home with continued outpatient mirror and auditory stimulus therapy, along with additional outpatient therapeutic care. He no longer had pain within a few months but took one year to recover proper use of his hand and digits. After that he was back to work as Occupational Therapy Technician and assisted in several surgeries.

3. Discussion

In our patient who presented with a severe laceration on their arm affecting the extensor muscle and tendon, sutures were used to repair the muscle tissue. However, the nerve had been severely lacerated and needed a nerve graft. Upon recovery, mirror therapy was used to help in hand rehabilitation. After the therapy, the patient demonstrated full hand function and could return to work. Hand therapy is often performed for patients with arms and upper body extremities injuries. After an overall evaluation and diagnosis, therapy is introduced. Therapy is crucial because it enables patients to return to normal bodily functions. Many studies have been conducted to understand the pathogenesis better and discover therapies for nerve healing and discomfort. Several post-operative therapies exist for cases of nerve damage, including isometric exercises [7] and "electrical stimulations" [8]. For our case, we used mirror therapy which is often non-contact. Mirror therapy enables central sensory processing by providing a physical image of the recovering limb.

Mirror therapy involves different procedures with the therapist. It as well includes tasks one can perform at home. Mirror therapy is one of these procedures that doctors currently perform. Nevertheless, the fact that it is still little comprehended proves to be a barrier. Signals relayed from the pre-motor and motor cortex in the restored limbs are validated by mechanoreceptors, sensory, and visual input. Furthermore, mirror treatment may improve sensory feedback by creating an illusory (mirror) representation of the signals in the non-functioning limb.

My patient therapy regimen focused on mirror therapy with audial input. The majority of the available literature focuses on visual, tactile, and proprioceptors input, with little or no discussion of auditory feedback produced by recognizable noises like clapping. Multi-sensor activations, modulations, and connections revealed in the early phases of sensory processing could enable a multisensory therapy strategy for limbs with restored nerves, with the prospect of stimuli consistency contributing even more.

Congruency is the connection among stimuli congruent with the person's previous experience or natural interactions among senses [9]. For example, the optical impression of clapping is paired with aural input (the distinctive sounds of clapping) generated by a psychotherapist or a third person. Similarly, one observing similar actions on one arm can stimulate the same actions in the healing hand. Though no "recorded" known noises were used, they are likely to be used in the future. Another illustration could be the patient's finger-snapping, which produces exceptionally particular sounds. Although a few sensory feedbacks may be more significant than others in arm perception, this report assumes that integrated, coherent, multisensory cues are vital in the entire process of hand restoration. There is evidence that mirror therapy can be paired with other sensory inputs. For instance, some studies further investigate the pairing of mirror therapy with other procedures, such as electrical stimulation [8]. It is unclear whether the restoration in normal motor functioning is attributed to mirror treatment alone or the combination of MVF and aural feedback. Additional cases, including multisensory input during therapy, are required to validate this concept.

4. Conclusion

In the therapy of motor-sensory restoration in patients with lacerated tendons and radial nerves, multimodal biofeedback treatment could be preferable to treatment only. This case included a patient recovering after surgery on their arm. After conducting mirror therapy, the pain was eliminated, and the patient restored normal function of moving the hand and finger extension. In addition, the therapy could be conducted at home without needing a professional. Further research into the impacts of multisensory activation in this patient group is required. We believe that a systematic study that compared mirror therapy by itself to combined MVF with auditory feedback could help respond to the following.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Thieme, H., Morkisch, N., Mehrholz, J., Pohl, M., Behrens, J., Borgetto, B. and Dohle, C. (2018) Mirror Therapy for Improving Motor Function after Stroke. *Cochrane Database of Systematic Reviews*, **7**, Article No. CD008449. https://doi.org/10.1002/14651858.CD008449.pub3

[2] Gandhi, D.B., Sterba, A., Khatter, H. and Pandian, J.D. (2020) Mirror Therapy in Stroke Rehabilitation: Current Perspectives. *Therapeutics and Clinical Risk Management*, **16**, 75-85. https://doi.org/10.2147/TCRM.S206883

[3] Bondoc, S., Booth, J., Budde, G., Caruso, K., DeSousa, M., Earl, B., Hammerton, K. and Humphreys, J. (2018) Mirror Therapy and Task-Oriented Training for People with a Paretic Upper Extremity. *American Journal of Occupational Therapy*, **72**, 7202205080p1–7202205080p8. https://doi.org/10.5014/ajot.2018.025064

[4] Rothgangel, A.S., Braun, S., Schulz, R.J., Kraemer, M., de Witte, L., Beurskens, A. and Smeets, R.J. (2015) The PACT Trial: Patient Centered Telerehabilitation: Effectiveness of Software-Supported and Traditional Mirror Therapy in Patients with Phantom Limb Pain Following Lower Limb Amputation: Protocol of a Multicentre Randomised Controlled Trial. *Journal of Physiotherapy*, **61**, 42. https://doi.org/10.1016/j.jphys.2014.10.001

[5] Hanyu-Deutmeyer, A.A., Cascella, M. and Varacallo, M. (2021) Phantom Limb Pain. StatPearls Publishing.

[6] Katsuyama, N., Kikuchi-Tachi, E., Usui, N., Yoshizawa, H., Saito, A. and Taira, M. (2018) Effect of Visual Information on Active Touch during Mirror Visual Feedback. *Frontiers in Human Neuroscience*, **12**, 424. https://doi.org/10.3389/fnhum.2018.00424

[7] Oliva, F., Via, A.G., Kiritsi, O., Foti, C. And Maffulli, N. (2014) Surgical Repair of Muscle Laceration: Biomechanical Properties at 6 Years Follow-Up. *Muscle, Ligaments and Tendons Journal*, **3**, 313-317. https://doi.org/10.32098/mltj.04.2013.12

[8] Saavedra-García, A., Moral-Munoz, J.A. and Lucena-Anton, D. (2021) Mirror Therapy Simultaneously Combined with Electrical Stimulation for Upper Limb Motor Function Recovery after Stroke: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Clinical Rehabilitation*, **35**, 39-50. https://doi.org/10.1177/0269215520951935

[9] Osumi, M., Ichinose, A., Sumitani, M., Wake, N., Sano, Y., Yozu, A., Kumagaya, S., Kuniyoshi, Y. and Morioka, S. (2017). Restoring Movement Representation and Alleviating Phantom Limb Pain through Short-Term Neurorehabilitation with a Virtual Reality System. *European Journal of Pain*, **21**, 140-147. https://doi.org/10.1002/ejp.910