Case Report

Effect of Mirror Therapy on Upper Extremity Function in a Patient with Humeral Fracture: A Case Study

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Abstract

Mirror therapy is the intervention aimed to improve functional aspects by creating a reflective illusion and mirror neuron system. Although there are many researches stating its effectiveness in neurological and orthopedic injuries, it has not been used widely in clinical settings for upper-limb fracture cases. A 69-year-old female sustained a right humeral shaft fracture and underwent open reduction internal fixation. Following the surgery, the patient was referred to the physiotherapy (PT) department for wrist drops, pain, and stiffness in the shoulder joint. The patient received conventional PT (electrical stimulation and exercises) for the first 3 weeks. Later, mirror therapy was introduced for wrist and shoulder movements. She was evaluated for pain, range of motion of shoulder and wrist joints, and functional ability at baseline, at 3 weeks, and at 6 weeks. There was an improvement in all outcome measures predominantly within 3rd week–6th week. Mirror therapy showed positive effects on upper-limb functions when combined with conventional therapy.

Keywords: Humeral fracture, Mirror therapy, Pain, Upper-limb function

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INTRODUCTION

Humeral shaft fracture accounts for around 3% of all orthopedic injuries. Older people above 50 years of age sustain humeral fractures with low-impact injuries such as simple falls at home or in the community. Further, radial nerve injury is one of the common complications of the humeral shaft fracture with the prevalence ranging from 2% to 17%.[1] As it majorly involves the shoulder and elbow, it affects the overall functional capacity of the person. Thus, the goal of physiotherapy (PT) needs to be directed toward improving the upper extremity function.

Access this article online	
Quick Response Code:	Website: www.ijptr.org
	DOI: 10.4103/ijptr.ijptr_162_22

Received: 06-10-2022, **Revised:** 23-06-2023,
Accepted: 05-07-2023, **Web Published:** 11-08-2023

Mirror therapy is the intervention aimed at improving functional movements by creating a reflective illusion of an affected limb through the use of mirror. It has shown an effect on the mirror neuron system which accounts for 20% of all the brain neurons. It was first introduced by Ramachandran and Rogers-Ramachandran[2] to decrease phantom limb pain in amputee patients. Further, it was used for poststroke hand or upper-limb rehabilitation effectively. There are many studies which reported its beneficial results in acute and chronic stroke upper-limb rehabilitation.[3,4] According to a systemic review done in 2009, the effectiveness of mirror therapy is proven in poststroke with complex regional pain syndrome (CRPS)

How to cite this article: Bansal K, Bansal N. Effect of mirror therapy on upper extremity function in a patient with humeral fracture: A case study. Indian J Phys Ther Res 2023;5:108-11.

and phantom limb pain, but its effectiveness in other patient groups is yet to be determined.[5] The visual feedback by mirror therapy produces cortical activation and further improves activity and participation levels.[6]

Although there are many researches stating its significance in upper-limb function in neurological conditions, it has not been used widely for upper-limb fracture rehabilitation. Recently, it has been studied in orthopedic injuries with a main focus on hand function.[7] We need to acknowledge that orthopedic injuries especially upper-limb fractures can result in disabilities in activities of daily living (ADL). Thus, this case study aimed to evaluate the effect of mirror therapy in patients with fractures of the shaft of the humerus along with radial nerve involvement.

CASE REPORT

A 69-year-old female with right-hand dominance sustained a fall in the house in May 2018. She was conscious and immediately taken to nearby hospital. X-ray findings revealed a displaced right-sided humeral shaft fracture. She underwent open reduction internal fixation with multiloc nail with two distal bolts. The patient was discharged in stable condition. Arm sling was advised for 15 days. Two months postoperatively, she was referred to PT for wrist drop management. She came to the department with a chief complaint of difficulty in the movements of the wrist joint. She also complained of pain and stiffness of the shoulder joint.

Clinical findings

Examination revealed right-sided wrist drop with complete passive wrist joint range of movement and restriction of shoulder active and passive range of motion (ROM) for flexion, abduction, and rotations. Further, restriction for interphalangeal joints was also observed. Strength duration (SD) curve was plotted for extensor carpi radialis, extensor carpi ulnaris, extensor pollicis, and abductor pollicis which showed partial innervation for the radial nerve. The functional status of the patient was assessed by the Disability of Arm, Shoulder, and Hand (DASH) questionnaire. The patient was unable to perform many activities (ADLs) such as self-care, dressing, opening a jar, writing, preparing meals, carry any object in hand, and doing overhead activities. She also reported of her social activity participation and confidence levels being affected because of the condition.

Physiotherapy intervention

The patient was treated with electrical stimulation for all muscles supplied by radial nerve with 90 contractions for each muscle. The interrupted galvanic current was used in the initial stage and later it was shifted to faradic current with simultaneous voluntary contraction. This intervention was continued for 3 weeks. As active movements were initiated, the electrical stimulation was discontinued. The patient was also prescribed with cock-up splint. Along with stimulation and splint passive ROM exercises were administered for the wrist and fingers during the initial phase which progressed to active-assisted exercises. The intervention also included hot pack for the shoulder joint, active assisted, and active ROM exercises for the elbow and shoulder joint, respectively. After 3 weeks, mirror therapy was started for wrist flexion/extension and shoulder flexion and abduction movements for another 3 weeks. The procedure of the mirror therapy was as follows:

1. The patient was asked to sit comfortably in the chair with backrest
2. Mirror was placed in the midsagittal plane in such a way that the nonaffected (left) upper limb was in front of the mirror and the affected (right) side was behind the mirror [Figure 1]
3. The patient was asked to perform symmetrical bilateral movements of the upper extremities while watching the image of the left upper limb reflected in a mirror which is superimposed to the image of the right upper limb. Each session lasted for 20 min [Figure 2]
4. The patient was asked to extend the wrist slowly and get it to the neutral position. Further, she was asked to perform finger extension, gripping exercises, and shoulder active flexion and abduction movement [Figure 3]
5. The exercises were done in random order
6. The patient was asked to perform two sets of 10 repetitions of each exercise. The rest period of 1 min was given between each set.

Figure 1: Positioning for mirror therapy

Figure 2: Mirror therapy for shoulder

Figure 3: Mirror therapy for wrist drop

Follow-up and outcomes

The patient was assessed at baseline (0 week), 3rd week, and 6th week of intervention with the following outcome measures:

Pain intensity at the shoulder joint was assessed by visual analog scale (VAS). The patient was asked to mark the intensity of pain on 10 cm horizontal line with 0 = no pain and 10 = severe pain. Patient's shoulder and wrist active ROM was measured with universal goniometer which has reliability of 0.7–0.9. The standard procedure of the ROM measurement was followed. The DASH questionnaire mainly focuses on the symptoms and functional ability of the patient to use his/her upper limb. The reliability (Cronbach alpha) of the questionnaire is 0.96.[8]

The pain, ROM, and functional status of the patient showed improvement as compared to baseline data (0 – week assessment). The shoulder pain (VAS score) was decreased by only 0.8 cm at 3rd week with conventional treatment (active-assisted exercises) and by 2.4 cm after introducing mirror therapy. At the end of 6 weeks, the VAS score for shoulder pain was reduced by 3.2 scores, and shoulder flexion and abduction active ROM improved by 65° and 85°, respectively, as compared to before treatment. The wrist extension ROM also improved from no active movement to 60° of motion. Further, the disability score (DASH) decreased by 46.25% [Table 1].

The AROM of shoulder flexion, abduction, and wrist extension also improved after the introduction of mirror therapy along with other exercises. As shown in Table 1, the functional capacity of the patient improved over 6 weeks as the percentage of disability (DASH score) decreased over 6 weeks. It showed almost a similar trend of improvement at 3rd week and 6th week.

DISCUSSION

The results showed the beneficial effects of mirror therapy in the rehabilitation of the patient with humeral shaft fractures. There was an improvement in pain perception, total ROM, and overall functional abilities of the patient. Previous studies had reported positive effects of mirror therapy on upper-limb functions in stroke patients, CRPS patients, and orthopedic injuries.[9-11] Mirror therapy gives visual imputes and suppresses inappropriate proprioceptive inputs. Few studies stated that mirror therapy helps in motor recovery through sensorimotor neuroplasticity.[12] Moreover, it activates the mirror neuron system which accounts for 20% of total brain neurons. These mirror neurons are responsible ability to differentiate between the left and the right side (laterality reconstruction).

Previous studies had shown pain reduction in amputee, CRPS patients. Similarly, our patient also showed a significant decrease in pain levels after the introduction of mirror therapy. The possible explanation for this can be the theory proposed earlier by researchers which says during movement, the brain continuously matches the visual and kinesthetic inputs and links what is seen and what is felt.[12] Further, mirror therapy given to the patient combined illusion and movement on the affected side, it helped in "sensory congruence"[13] which in turn led to pain reduction. The pain reduction could be one of the reasons for the improvement of ROM at the shoulder and eventually the functional ability of the upper limb.

From the patient perspective, the patient reported great improvement in confidence level. Before PT intervention, the patient was worried about functional independence as she was not able to perform functional activities such as self-care, preparing meals, and overhead activities. It

Table 1: Clinical findings pre- and postintervention

Description	Preintervention (0 week)	Postintervention-1 (3 weeks)	Postintervention-2 (6 weeks)
VAS	5.6	4.8	2.4
Shoulder flexion AROM (°)	0–90	0–110	0–155
Shoulder abduction AROM (°)	0–20	0–55	0–115
Wrist extension AROM (°)	Nil	0–20	0–60
DASH score (%)	85.25	63	39

VAS: Visual Analog Scale, AROM: Active range of motion, DASH: Disability of Arm Shoulder Hand Questionnaire

impacted her social life as she used to avoid going out due to the embarrassment felt. However, the improvement in functional abilities gave her sense of confidence. This in turn improved her social life as she started going out for functions, shopping etc., which improved her quality of life. The influence of the positive attitude of the patient toward new therapy, i.e., mirror therapy cannot be overlooked.

CONCLUSION

This case study concludes that mirror therapy after humeral shaft fracture has positive effects on its function when used in combination with conventional therapy. Thus, it should be incorporated in the fracture rehabilitation protocol.

Clinical implication

The results of the study are encouraging for the effectiveness of mirror therapy in orthopedic conditions. Mirror therapy was traditionally developed for neurological or CRPS conditions. However, the outcomes of the case study have given new insight toward the incorporation of mirror therapy in the rehabilitation of fracture cases with or without neurological damage.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent about clinical information to be reported in the journal without her pictures. Therefore, images used are for illustrative purposes only and do not depict real patient. Further, the patient understands that her name and initial will not be published and due efforts will be made to conceal her identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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