



Efficacy of Mirror Therapy on Post-burn Elbow Contractures in Adolescent: A Randomized Clinical Trial

¹Hanady A. Mouhamed, ²Nehad A. Abo-zaid, ³Maha H. El Gharib, ⁴Mahmoud A. Elkholy, ⁵Marwa A Aziz, ⁶Manal Mohammed Hassan, ⁷Mohammed E. Ali

¹Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, Benha University, Benha, Egypt. E-mail: dr.hanady@fpt.bu.edu.eg

²Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, South Valley University, Qena, Egypt. E-mail: dr.nehadahmed@svu.edu.eg

³Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, Benha University, Benha, Egypt. E-mail: maha.elgharib@fpt.bu.edu.eg

⁴Department of Physical Therapy for Integumentary System Disorders and Burn, Faculty of physical therapy, Beni-suef University, Egypt. E-mail: mahmoud.elkholy@pt.bsu.edu.eg

⁵Department of Physical Therapy for Women Health, Faculty of Physical Therapy, Deraya University, Minia, Egypt. E-mail: Dr.miroo86@yahoo.com

⁶Department of Physical Therapy, Basic science, Faculty of physical, Faculty of Physical Therapy, South Valley University, Qena, Egypt. E-mail: manalesa25@svu.edu.eg

⁷Department of Physical Therapy for Integumentary System Disorders and Burn, Faculty of Physical Therapy, South Valley University, Qena, Egypt. E-mail: m.essam@svu.edu.eg

Abstract—

Background: Burn injury represents a significant problem worldwide Flexion contracture of the elbow is a common sequela of burn injury can interfere daily activities, such as grooming, dressing, eating, and bathing, as well as fine motor skills.

Aim: To investigate the effect of Mirror Therapy (MT) in management of Post-burn Elbow Contracture (PEC) in Adolescent.

Participants and Methodology: Thirty children with Post-burn Elbow Contracture were enrolled in this study after the assessment of their eligibility. Their age ranged from 14-18 years. They were divided randomly into two groups equal in numbers. Group (I) received a traditional physical therapy program, and group (II) received MT in addition to the same traditional physical therapy program. The two groups received treatment protocols three times / week for four successive weeks. Electrogoniometer was used to assess the range of motion

(ROM) of elbow joint; also The Upper Extremity Functional Index (UEFI) was used to measure of quality of life after a burn. All measurements were collected before and after four successive weeks of applying the different treatment protocols.

Results: Post-treatment findings, demonstrated a statistically significant improvement in all measured values of ROM of elbow flexion, as well as UEFI outcomes in both groups in favor of MT group ($P < 0.05$).

Conclusions: Mirror Therapy can provide a great statistical significant effect in management of Post-burn Elbow Contracture in Adolescent.

Keywords— Mirror Therapy, Elbow Contractures, Elbow flexion ROM.

I. INTRODUCTION

For the development of social, physical, and cognitive functioning, childhood is a crucial time. Sadly, burns are rather frequent all across the world, especially among children(**Disseldorp et al., 2012**). Burn injuries may be extremely traumatic events with lasting effects that might start in childhood and adolescent and go into adulthood (**Thaller, 2008**).

Contractures are one of the most prevalent limitations that occur after a burn injury. Contractures are frequent in big joints (shoulder, elbow, hip, and knee), and they can limit functional movement and ADL. (**Curtis and Kevin, 2011**). Flexion contracture of the elbow is a typical side effect of severe burn (**Schneider et al., 2006**).

The risk of contracture is higher when burns involve the flexor side of a joint or limb. This is because flexed positions are more comfortable, and because flexor muscles are typically stronger than extensor muscles, patients can utilize their flexor strength to stretch the affected region in the event of an extensor aspect burn. (**Fiona Procter, 2010**)

The most prevalent late consequence of burn injuries is elbow flexor contracture. Various techniques for post-burn elbow flexion contracture release have been proposed, including grafting, Z-plasty, Y-V flaps, local or distant

fasciocutaneous flaps, muscle or myocutaneous flaps, free flaps, and tissue expanders. (**Gurcanet al., 2006**) and non-surgical modalities such as positioning, splinting, range of motion exercises, stretching exercises, massage and moisturising. (**Fiona Procter, 2010**)

When ignored, severe disabling and deforming contractures caused by burns can leave a patient with substantial impairment. The objectives of burn rehabilitation are to maximize functional ability, psychological well-being, and social integration while minimizing the negative effects of the injury in terms of preserving range of motion, minimizing contracture formation and the affecting scarring. (**Fiona Procter, 2010**)

Mirror therapy (MT) is an easy, efficient, and inexpensive approach that uses visual feedback caused by non-affected limb movement in the mirror to increase the mobility of non-affected limbs. [**McInnes , Friesen , Boe . 2016**]. Three major mechanisms explain MT. 1) It aids locomotor rehabilitation by giving visual input on the movement of the normal side, which reflects stimulation of the affected side's movement. [**Abo-zaid et al., 2020, Funase, Tabira, Higashi, et al. 2007**]. 2) Mirror neuron activation, which aids in the movement of the affected side [**Cattaneo and Rizzolatti 2009**]. 3) Simultaneous motion of health and damaged limbs that stimulates the damaged cerebral cortex through interactions with non- damaged cerebral cortex stimulation [**Summers, Kagerer, Garry, et al. 2007**].

In patients with severe burns, managing upper-extremity burn contractures can be challenging. Functional restoration is crucial since significant burn scarring always makes it difficult for patients to go about their usual everyday lives. (**Trong et al., 2001**). So our study aimed to evaluate the effect of MT in management of PEC in Adolescent. We hypothesized that adding MT to the traditional physical therapy program has a great effect in management of PEC in Adolescent.

PARTICIPANTS AND METHODOLOGY

Study Design

A single-blinded randomized controlled study was authorized by the Faculty of Physical Therapy's ethics committee at Cairo University, Egypt and also registered in Clinicaltrial.gov. Our study was carried done in the private outpatient clinics, during the period from April 2019 to September 2021. The informed consent and procedures had been signed by each child`s parent to ensure satisfaction before starting the study.

Randomization

Thirty patients with PEC from both sexes were assisted for eligibility before enrolled to our study. They were classified randomly to two groups equal in numbers, minimizing the selection bias by using random allocation software (Saghaei, 2004). The diagram of patient's randomization is shown in fig (1).

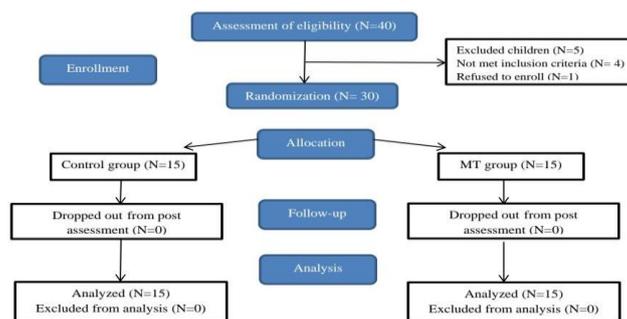


Fig. (1): Flowchart of children randomization

Study population

All thirty patients were evaluated and referred by an experienced special surgeon. The selected patient`s age ranged from fourteen to eighteen years old, they have third and second degree burn elbow burn, and limited elbow flexion ROM. We excluded from our study patients with hearing, vision and cognition problems, and patients with a history of epilepsy or convulsions, or patients with motor neuron diseases.

Outcome measures:

- 1- Elbow Flexion Range Of Motion (ROM):** It was measured by electrogoniometer, which is an electronic versions of the standard

goniometers used to measure joint ROM or angular displacement, that consists of two arms (one fixed and the other is movable) connected by a fulcrum and large LCD for easy reading. It has several advantages such as ease of set up and processing, low cost, portability for data collection, light and flexible to wear (**Chao et al., 2009**).

2- Quality of life: It was assessed using the Upper Extremity Functional Index (UEFI), a self-administered questionnaire that assesses impairment in persons with upper extremity orthopaedic disorders. The questionnaire has a list of 20 tasks and the patient assigns a score of each depending how difficult it is for them to complete that activity as in (Appendix 1) (**Stratford et al., 2001**).

- **Scoring and interpretation of scores:**

The points for the 20 questions are summed together to yield a maximum potential score of 80. The lowest score achievable is 0. A lower score implies that the client is having trouble with activities due to their upper limb disease. (**Stratford et al., 2001**) established the following guide to interpretation of a patient score (0 = Extreme difficulty or unable to perform activity. 1 = Quite bit of difficulty. 2 = Moderate difficulty. 3 = A little bit of difficulty. 4 = No difficulty).

Methods of Treatment

The control group:

- This group included 15 patients of upper limb burn that received 60 min. of traditional physical therapy program for burn management which include ROM exercises for all affected joints of burned upper limb and positioning (**Jeffrey et al., 2012**)

The MT group:

- This group included 15 patients of upper limb burn that received a 30 min. of the same traditional physical therapy program for burn management, plus 30 min. of MT in management of burned upper limb.

- The patients were advised to sit in a chair while a mirror was put in the patient's mid-sagittal plane, with the normal upper extremity in front of the mirror and the affected upper extremity blocked inside the box, so that the patients only observed the reflected movement of the sound limb; the patients were asked to make repetitive movements of elbow flexion and extension, forearm supination and pronation, wrist flexion, extension, radial and ulnar deviation the movement of burned limbs through the reflection in the mirror shows a visual illusion of normal movement.
- All patients received the different treatment protocols 3 times/week for four successive weeks.

Samples size:

G power program version 3.1, Heinrich-Heine-University, Düsseldorf, Germany was used to calculate sample size based on F tests (MANOVA: Special effects and interactions), Type I error (α) = 0.05, power (1- α error probability) = 0.80, Pillai V = 0.30 and effect size f^2 (V) = 0.4285. The appropriate minimum sample size for this study was 22 patients. The effect size was calculated according to a pilot study on ten participants considering elbow flexion ROM, and UEFI scores as outcome measures.

Statistical analysis:

Before the final analysis, the data were tested for normality assumptions using the Shapiro-Wilk test, which reveals normally distributed data ($P > 0.05$). Furthermore, Levene's test was employed to assess variance homogeneity, which indicated no significant difference ($P > 0.05$). Because the data was regularly distributed, parametric analysis was used. SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL. Regarding demographic information, elbow flexion range of motion, and UEFI measurement, all results were reported as mean and standard deviation. Each group's pre- and post-treatment characteristics were compared using a paired t-test. The variables between the two groups were compared using an unpaired t-test before and after the therapy. Test group with

two levels was the first independent variable (between-subject variables) (control group and study group). The testing period prior to and following treatment served as the second independent variable (within-subject factor). The elbow flexion ROM and UEFI were the two dependent variables. The significant level indicated as ($P \leq 0.05$).

Thirty children with PEC took part in this trial, with 15 patients assigned at random to each group. There were no significant changes in age, weight, height, or BMI between the control and MT groups. (Table 1).

Table 1: Comparison of mean values of demographic data among two groups.

Variables	Groups (mean \pm SD)		Sig.
	Control group	MT group	
Age (years)	15.34 \pm .87	15.35 \pm .86	0.973
Height (cm)	160.37 \pm 6.32	159.53 \pm 6.9	0.730
Weight (kg)	55.7 \pm 2.46	55.89 \pm 2.74	0.840
BMI (kg/m ²)	21.78 \pm 1.47	22.09 \pm 2.4	0.677

Numerical Data are expressed as mean \pm SD or number (%) P-value>0.05: non-significant

The statistical analysis within each group represented a statistical significant ($P < 0.05$) increase in elbow flexion ROM and UEFI at after treatment in comparison with before treatment within the control group and MT group.

The statistical analysis between the two groups reported that there were no statistical significant differences ($P > 0.05$) in mean values of before treatment elbow flexion ROM and UEFI. However, there were statistical significant differences ($P < 0.05$) in the mean values of after treatment elbow flexion ROM, and UEFI between the two groups in favor of MT group (Table 2).

Table 2: Comparison by t-test for all dependent measuring variables within and among two groups.

		Control group		MT group	
		Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Elbow flexion ROM (degrees)	\bar{x}	60.67	94.17	61.92	120.55
	\pm SD	18.88	19.37	17.93	18.08
	MD	-33.5		-58.63	
	% of improvement	55.21		94.68	
	T- value	-14.31		-15.07	
	p-value	0.0001		0.0001	
UEFI	\bar{x}	22.8	40.33	23.06	48.8
	\pm SD	3.85	2.96	4.74	6.52
	MD	-17.53		-25.74	
	% of improvement	76.88		111.62	
	T- value	-22.65		-22.65	
	p-value	0.0001		0.0001	

SD: standard deviation

P-value: probability value

*non- significant (P-value >0.05)

DISCUSSION

Upper limb burns are projected to hospitalize over half a million people worldwide each year, with the majority occurring in low to middle income nations in Asia and Africa. Scar deformations and contractures are caused by wounds and late skin transplantation. Secondary contractures, which occur after joint contractures, include muscles and tendons. The end outcome of a contracture at a joint site is a decrease in ROM of the joint, which limits extremity mobility. So our study aimed to evaluate the effect of MT in management of PEC in

Adolescent. Our findings showed a statistical significant increase in elbow flexion ROM after 4 weeks of treatment application

Pre-treatment our findings showed that there were limitation of elbow flexion ROM and UEFI in both groups this comes in agreement with **Baux, 1987** who concluded that contractures of the elbow are common following a burn injury and are frequently associated with additional contractions., also **Ball et al., 2002** stated that developing contractures could affect the ability to perform full joint ROM.

Post-treatment our results revealed that there were significant improvement in mean values of elbow flexion ROM and UEFI as compared to pre-assessment mean values in both groups. This may attributed to the application of traditional physical therapy program which is supported by **Schmitt et al., 2011** who reported that physical therapy can help counteract the reduced ROM and lessen the severity of the contractures that may form with early and active intervention. Also **Simons , King , and Edgar, 2003** concluded that physical therapy can decrease ROM restrictions, contractures, muscular weakening, and deconditioning. On the other hand improvement in UEFI scores post-treatment may be attributed to physical therapy rehabilitation after burn that supported by **Rejeski, Brawley, Shumaker, 1996** who concluded that health-related quality of life of adolescent burn is improved by physical activity.

On the other hand our finding showed that there was highly significant improvement of mean values of elbow flexion ROM and UEFI in MT group as compared to control group this may be due to MT. Using MT was related to a easy and affordable, and method for patient-orientation [**Altschuler and Hu, 2008**]. It was found to have a significant impact on phantom pain sensations following amputation, as well as increased ROM, velocity, arm movement

function, and accuracy [**Zeng et al., 2018**] and the primary motor cortex is also activated (M1) [**Garry, Loftus, and Summers, 2005**].

Rehabilitation with MT has many advantages such as visual feedback training and imagery training [**Yavuzer, Selles and, Sezer, 2008, Stevens and Stoykov, 2003**], as it employs a visual illusion in which patients mistake the image reflected from their normal limb for that of the damaged limb. [**Stevens and Stoykov, 2003**]. It also compensated for the loss of proprioceptive input by obtaining normal visual feedback in the form of a mirror image of a normal limb. [**Ltschuler, Wisdom, and Stone, 1999**].

The improvements in ROM in MT group supported by **Aymeric Guillot, 2009** who concluded that MT training program combined with conventional rehabilitation program for two weeks improve the motor functions of fourteen handed burn patients. Also **Shaker et al., 2020** concluded that 8 weeks of MT a significant impact on enhancing hand motor functional abilities in a group of chronic stroke patients from Egypt.

Limitations:

The psychological aspects of adolescent`s recovery have not been investigated, which may have an impact on the outcome measures.

Conclusion

The findings of our study showed that MT has an evident therapeutic effect in management of PEC in Adolescent. More research is needed to assess the long-term effects adding MT to the traditional physical therapy program in management of PEC in Adolescent to ensure our statistical findings.

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