

Effectiveness of early rehabilitation in hand burns

Sevgi Kara, PT,¹ Nevra Seyhan, M.D.,² Sinan Öksüz, M.D.,²

¹Gülhane Training and Research Hospital Burn Center, Ankara-Türkiye

²Gulhane Education and Research Hospital Department of Plastic, Reconstructive and Aesthetic Surgery, Ankara-Türkiye

ABSTRACT

BACKGROUND: Hand burn trauma occurs quite commonly and the outcome of hand burns can significantly impact self-care daily function, work and employment, leisure activities, and overall health-related quality of life. The overall goal of the management of hand burn trauma is to optimize hand function. Rehabilitation and restoration of hand function are critical for the patient's independence and re-integration into society and work. The purpose of this study is to present our experience with 105 hand burn trauma patients admitted and treated in our burn center and to show the efficacy of early rehabilitation on their ability to return to their prior social life and work.

METHODS: In our study, we included that 105 patients with acute severe hand burn trauma were hospitalized in Gulhane burn center between 2017 and 2021. They underwent rehabilitation program daily sessions. Patients with hand burns are evaluated by ranges of motions (ROM), grip strength, Cochin Hand Function Scale (CHFS), and Michigan Hand Questionnaire (MHQ) 12 months after the injury.

RESULTS: Overall, mean digital total active motion were $>180^\circ$. The mean values for grip strength of dominant hand for men were 27.2 ± 9.3 kg, for women were 22.0 ± 8.8 kg and non-dominant hand for men were 24.05 ± 13.8 kg, for women were 17.8 ± 10.3 kg. Total score of 5 items was 19.0 in CHFS. The mean overall score on the MHQ was 62.3 ± 27.4 . All obtained data were within normal or accepted functional ranges. Spearman correlation coefficient indicates a negative correlation between MHQ and CHFS ($p < 0.01$).

CONCLUSION: A comprehensive rehabilitation program is essential in helping patients to regain optimal function after hand burn trauma. Physiotherapy and occupational therapy is most beneficial when started at the time of admission.

Keywords: Burn; hand; rehabilitation; trauma.

INTRODUCTION

Hands are the most frequent sites of burn trauma.^[1] Burns to the hand occur in more than 90% of severe burns.^[2] Although each hand represents <3% of the total body surface area, burns to the hand are considered serious injuries and should be referred to a burn center.^[3] With the increasing rate of surveillance and progress in acute burn trauma care, hands have become more important for functional restoration.^[4]

The resulting loss of function of hands from burns trauma can have a devastating effect on the numerous life roles of the patient at any age, especially employment status and ac-

tive work life. The aim of early rehabilitation after hand burn trauma is to maintain mobility, prevent the development of contracture, and to promote the functionality of hand and good cosmetic result.

Early rehabilitation is essential to assure that optimal functional recovery is achieved and one of the main goals of rehabilitation is to help patients to regain their social status and professional skills and work productivity.^[5] Early goals in burn treatment must be to aid in decrease edema and pain, to keep muscle strength, to increase range of motion (ROM) with joint mobility, and to prevent the development of contractures and other deformities.

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Address for correspondence: Sevgi Kara, PT.

Gulhane Education and Research Hospital, Ankara, Türkiye

E-mail: sevkara@yahoo.com



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The purpose of this study is to present our experience with 105 hand burn trauma patients who admitted and underwent early rehabilitation program during treatment in our burn center and to show the efficacy of early rehabilitation on these patients.

MATERIALS AND METHODS

In this study, we included 105 patients with acute severe hand burn trauma hospitalized in Gulhane Training and Research Hospital Burn Center. The age range of the patients was 18–65. The hand burns were all deep second and third degree. 105 hand burn patients who underwent early rehabilitation program hospitalized in our burn center between October 2017 and December 2021 are evaluated by ROMs, grip strength, Cochin Hand Function Scale (CHFS), and Michigan Hand Questionnaire (MHQ). These measurements were made 12 months after their discharge.

The patients with serious trauma such as spinal cord and brain injury were not included in the study. The study is approved by ethics committee of our hospital with an approval number 198/22.

Basic personal demographic details including age, gender, education, marital status, length of hospital stay, as well as the degree of burn trauma and mechanism, surgical interventions, hand involvement, and problems resulted from burn such as deformities, amputations, nerve injuries, ankyloses were all recorded. Informed consent to participate in this study was obtained from all patients.

Rehabilitation Program

Physical and occupational therapy (OT) in patients admitted to our burn center following burn trauma began with the patient's hospitalization within the first 24 h by a physiotherapist of our burn unit and continued until they have been discharged and followed by home program.

Edema management

Holding the hands in elevation and anti-deformity position, compression with pressure garments and bandages, active ROM exercises, occupational activities compliant with their previous employments, and massage were all contributed in reducing edema. In the early period of rehabilitation program, our priority was to encourage patients to perform daily activities of life such as eating, dressing, and personal hygiene.

Positioning

Keeping the hand in functional position prevented neuropathy and contracture. The functional position of the hand is the position of the wrist 0–30° of extension and metacarpophalangeal (MCP) 60–90° of flexion. Due to this positioning in there habilitation program in our clinic, collateral ligaments were strained and thus prevented joint stiffness and claw hand deformity.

Splinting

In the early period, the splint was performed in the scar mat-

uration process to be able to maintain the functional position and to prevent the deformities that can be caused by the scar contracture in the late period. Besides, they were used for protecting the anatomical structures such as splinted bones and tendons, to prevent or correct the deformities due to electrical and deep third burns, and to protect the grafted area post-operatively.

Exercise and Occupational Therapy

In the burn patients, the therapeutic exercise program including passive, active, and active-assisted exercises increased muscular strength and prevented atrophy. Coordination exercises and isometric and strengthening exercises during this period helped to improve the patient's functional status.

Following grafting of the wound, immobilization for 5–10 days with splints at functional position was considered necessary for the integrity of the graft. Stretching exercises were applied in the treatment program to prevent functional limitations in the period following wound closure.

Individual patient-specific functional activities added to the treatment program were applied to all patients for self-care, work and productive activities and leisure time activities, helping patients to continue their roles and routines independently.

Scar management

Clinical trials have shown that the most effective method of preventing immature scar tissue is compression therapy. Elastic bandages were used for patients who were not able to conceal the pressure glove at the beginning of the treatment. In later periods, fabricated or customized print gloves were used to minimize the scar formation. Foams, silicone elastomers, silicone gels, gel polymers, and thermoplastic materials have often been used to provide adequate pressures in critical regions. Maximum attention was paid to 24–28 mmHg for the pressure to be active. Patients used their clothing for 24 h and at least 3 months concerning the efficacy of compression therapy.

Assistive device

We supplied assistive device according to the need of the patient for helping them to participate their daily routine activities and occupational life independently.

Occupational rehabilitation

Occupational rehabilitation is based on arrangement of ergonomics in working places and help patients to find appropriate jobs suitable for their skills

The patients were invited to routine controls every month during one year after their discharge to train them for the prevention of deformities and contracture development.

Outcome measures

The method of total active motion described by the American Society for Surgery of the Hand is useful in evaluating

burned hands. Active and passive joint ROM is assessed using a goniometer.^[6] The obtained data <180° were considered as poor, 180–219° as good, and 220–259° as excellent. Grip strength is measured by Jamar dynamometer^[7] (Sammons Preston, Inc., Bolingbrook, IL, USA).

The patients grabbed the dynamometer with their maximum strength for 2–5 second in shoulder adduction and neutral, elbow at 90° flexion, forearm, and wrist in neutral position. This maneuver has been repeated for three times. The result of the test was determined by calculating the average of three measurements. Hand functions are evaluated with CHSF^[8] and MHQ.^[9] CHSF is a scale that evaluates restrictions and functional performance of the hand. It contains 18 items such as kitchen (0–40), dressing, office work, and other activities (0–20). The maximum total score is 90. High scores indicate the severe restriction of activity and having difficulty in working.

The MHQ is a hand-specific outcomes instrument that measures the health outcome of patients with chronic hand conditions.^[10] It is a hand-specific patient questionnaire comprising 37 questions that are categorized into six scales including overall hand function, pain, work performance, esthetics, and patient satisfaction with hand function. Each of the items is scored 0–100. High scores show better performance except for pain. Turkish version of this questionnaire is written by Öksüz et al.^[11]

Data Analysis

All data were normally distributed according to Kolmogorov–Smirnov test. Descriptive data were expressed as the mean and standard deviation. Categorical data were expressed as number (n) and percentage (%). SPSS v21.0 (SPSS Inc., Chicago, IL, USA) is used for analyzing the data. Spearman's rank correlation test is used to assess the linear equation among grip strength, MHQ, and CHFS. $p < 0.05$ was considered as statistically significant.

RESULTS

A total of 105 adult burn patients participated in the study.

The majority were male (88.6%) with an average of 43.2 years (range: 19–65 years). The majority were right hand dominant (87.6%). The number of patients with left hand burn was 20 (19%), with right hand burn was 16 (15.2%), and both hands burned patients was 69 (65.7%). The most common etiology of the burn trauma was thermal including flame, contact with hot objects and scalds (87.5%) followed by electrical (10.5%) and chemical burns (1.0%).

The reconstructive operation was split-thickness grafting in 98 (93.3%) patients and flaps in 15 (14.2%) patients. The hand burns were third degree in 64.8% patients and deep second degree in 35.2% patients. The mean total burned body surface area was 32%.

The average hospitalization period was 127 days. About 81% of the patients who received rehabilitation during hospitalization period recovered without developing any deformity. Syndactyly was seen in 6 of the patients (5.7%), 2 (1.9%) mallet fingers, boutonniere deformity in 2, and swan neck deformity in 1 (1%) patient.

Median nerve injury was detected in 4 (3.8%), ulnar nerve injury in 8 (7.6%), and radial nerve injury in 1 patient (1%). Flexion contracture of distal interphalangeal and proximal interphalangeal (PIP) joints of little and ring fingers was seen in 6 (5.7%) patients, extension contracture of MCP joint has developed in 1 patient (1%). In 3 of the patients, index and middle digits at PIP level were amputated.

We made our measurements and gave the questionnaire to the patients; 1 year after burn trauma rehabilitation program was completed. Measurement of total active motion for each digit is shown in Table 1. The normal value of total active motion measure of the thumb according to the American Academy of Orthopedic Surgeons is 145°. Overall, mean digital total active motion was all within normal or accepted functional ranges. The mean values for grip strength of dominant and non-dominant hands for both men and women are demonstrated as kilogram in Table 2. The grip strength of 11 kg for functional use of the hand is accepted as sufficient.^[12]

The average results of CHFS are shown in Table 3. Total score

Table 1. Mean total active motion of both hands

Digit	Right hand	Left hand
	Mean total active motion	Mean total active motion
Thumb	115±39	118±46
Index finger	212±44	205±53
Middle finger	214±40	211±63
Ring finger	208±54	214±55
Little finger	205±64	198±65
Thumb abduction	55±29	52±36

Values are mean degrees±SD.

Table 2. The mean values for grip strength of dominant and non-dominant hands for both men and women

	Dominant hand		Non-dominant hand	
	Mean	Normative	Mean	Normative
Women	22.0±8.8	26.9	17.8±10.3	26.5
Man	27.2±9.3	46.5	24.05±13.8	44.5

Values are mean kilogram±SD.

Table 3. The average results of CHFS

	Mean±SD
Kitchen	8.3±5.8
Dressing	2.7±1.8
Cleaning	1.2±1.7
Office work	1.3±2.0
Other	5.3±3.0
Total	19.0±13.9

Values are mean±SD. CHFS: Cochin Hand Function Scale.

Table 4. Mean scores of MHQ for each item

MHQ scale	Mean
Hand function	68.6±18.7
ADLs	58.3±26.7
Work performance	59.8±27.4
Aesthetics	60.3±21.1
Satisfaction	61.7±18.7
Pain	69.1±23.2
MHQ final score	62.3±27.4

Values are mean±SD. MHQ: Michigan Hand Questionnaire.

of 5 items was 19.0. Maximum score is 90, and lower scores point out good performance.

Our findings show good hand function of the patients. The difficulties mostly encountered in the kitchen were slicing meat with the knife, uncovering jar, counting coins, and cutting the paper with a scissor.

Mean scores of MHQ are given in Table 4. Of the 6 components in the MHQ, subjects reported the most difficulty in performing ADLs, such as turning a door knob, tying shoes, holding a glass of water, turning a key in a lock, and holding a frying pan. The mean overall score on the MHQ was 62.3±27.4.

The MHQ scores were moderate to good across all domains with the exception of pain which scores were low, indicating little residual pain.

The correlation between grip strength, MHQ, and CHFS is shown in Table 5. Spearman's correlation coefficient indicates a negative correlation between MHQ and CHFS.

The scores increased in hand function component of MHQ and decreased in all CHFS items ($p \leq 0.01$), which meant that patients began to use their hands more efficiently in their daily lives and work life.

DISCUSSION

Burn trauma affects people's lives in all aspects with long-term

Table 5. The correlation between grip strength, MHQ, and CHFS

MHQ	Subscales CHFS						Grip strengths
	Kitchen	Dressing	Hygiene	Office	Other	Total	
Hand function	-0.710**	-0.635**	-0.572**	-0.490**	-0.778**	-0.748**	0.596**
ADLs	-0.819**	-0.802**	-0.710**	-0.588**	-0.765**	-0.868**	0.671**
Work	-0.729**	-0.659**	-0.616**	-0.557**	-0.759**	-0.751**	0.596**
Pain	-0.602**	-0.464**	-0.453**	-0.552**	-0.557**	-0.582**	0.467**
Aesthetics	-0.379**	-0.304*	-0.334**	-0.266*	-0.492**	-0.428**	0.227
Satisfaction	-0.660**	-0.572**	-0.557**	-0.399**	-0.743**	-0.689**	0.491**
Total MHQ score	-0.773**	-0.741**	-0.604**	-0.509**	-0.835**	-0.808**	0.555**
Grip strengths	-0.674**	-0.645**	-0.657**	-0.544**	-0.640**	-0.686**	

* $P=0.05$; ** $P=0.01$; MHQ: Michigan Hand Questionnaire; CHFS: Cochin Hand Function Scale.

consequences. Patients are confronted with a diversity of physical, psychological, social, and emotional problems during their recovery process.^[13] Hand burns occur commonly both as part of larger burn injuries and isolated injuries and are a leading cause of impairment after burn injury.^[14] Early physiotherapy and OT interventions are essential to achieve best functional outcomes, particularly because the hand is among the most common areas for scar contracture development after a burn.^[15] Positioning and splinting as we did in our rehabilitation program are important preventive measures for contracture development.

Hand function has also been shown as a strong predictor of physical quality of life after a massive burn injury.^[16] We obtained good results from both MHQ and CHFS.

There are several common burned hand deformities that include Claw hand deformity, Boutonniere deformity, Mallet and Swan-neck deformity, Scar-band deformities, and peripheral nerve injuries.

Salisbury^[17] outlined the most common deformities seen after hand burns trauma: Web space contractures, dorsal skin contractures, fifth finger abduction deformity, MP joint extension deformities, extensor tendon adhesions, and PIP flexion deformities.

The potential complications after an upper extremity burn trauma can lead to loss of ROM, joint contractures, and devastating functional limitations such as neuropathy and amputation.^[18] In our patient group, only three of the patients had amputations at digital level.

A comprehensive rehabilitation program is essential to help patients regain optimal function. Application of physical therapy and OT in the early phase in a hand burn patient is very important and consists in the prevention of edema, contracture, maintaining or improving ROM, functional recovery, and preventing of development of keloid scars.^[19] For this reason, we gave great importance to apply compression therapy to our patients to prevent development of keloid scars.

Aggressive ROM should be started soon after admission to the burn center for most partial and full-thickness hand burns.^[20] The patients must be acknowledged about how the early rehabilitation will affect their physical, social well-being, and work productivity and encouraged for acceptance of treatment even though they may resist due to pain.^[21]

The traditional methods of assessment are ROM and grip strength, but it is important to assess an individual's ability to actually use their hands.^[22] For this reason, we used CHFS and MHQ in our study.

Return to work after burn injury is the prior concern of the patient. Delay in returning to their work life causes a major burden on their family. This is achieved by early occupational rehabilitation.^[23,24] In our rehabilitation program, we applied OT simultaneously with physiotherapy.

Burn rehabilitation should be initiated within the first 24 h of admission of a burn patient.^[25] We started daily life exercises as soon as the patient was hospitalized and we individualized a rehabilitation program including positioning, splinting, exercise, assistive device, occupational rehabilitation to each of our patients. In this way, we minimized many of the complications previously described.

For those with severe burns, the scarring and deformity cause impairment of movement, commonly followed by depression, post-traumatic stress disorder, dysmorphic perception, and lack of self-confidence.^[26] Rehabilitation for these patients is a long-term process which requires physical, psychological and social adaptation, return to work and should start before and last for a long time after discharge from hospital.^[27] We also encouraged our patients to receive psychotherapy during the time they spent in the hospital and even after their discharge.

Most doctors and hospitals focus on medical treatment rather than on rehabilitation. Therefore, many burn patients suffer from serious disabilities because of the lack of the concept of early rehabilitation after injury.^[28] Many previous studies around the world have shown that functional outcomes can be improved by early rehabilitation interventions.^[29-31] Our findings are in accordance with them.

The ultimate goals of hand burn management should be to maximize and restore function through proper initial treatment. It is likely that in-patient and post-discharge rehabilitation improves the range of movements, muscle strength, and prevents long-term limb deformities to avoid further disabilities. To monitor treatment and rehabilitation progress, evaluations of functional outcome of burn patients are imperative.^[32] Keeping this point in mind, we continued our rehabilitation program after the discharge of our patients from the hospital. We observed improvement of their hand functions in their daily routines.

The limitation of our study is that we did not include a control group because we applied early rehabilitation program to each patient hospitalized in our burn unit at the time of admission. Creating a control group and not apply rehabilitation program would not be considered as ethical for benefits of the patients and deprive them from our standard rehabilitation program; instead, we compared our results with normal accepted hand function values.

Conclusion

A comprehensive physiotherapy and OT program is essential in helping patients to regain optimal function after hand burn trauma and reintegration to social and work life. Therapy is most beneficial when started at the time of admission and may be needed for weeks or months following discharge.

Consequently, with early rehabilitation interventions after hand burn injury, patients show better functional outcomes. Depending on our findings, we suggest starting rehabilitation as early as possible for hand burn patients.

Ethics Committee Approval: This study was approved by the Gulhane Education and Research Hospital Clinical Research Ethics Committee (Date: 26.05.2022, Decision No: 2022-198).

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ORİJİNAL ÇALIŞMA - ÖZ

El yanıklarında erken rehabilitasyonun etkinliği

Fzt. Sevgi Kara,¹ Dr. Nevra Seyhan,² Dr. Sinan Öksüz²

¹Gülhane Eğitim ve Araştırma Hastanesi Yanık Merkezi, Ankara, Türkiye

²Gülhane Eğitim ve Araştırma Hastanesi, Plastik, Rekonstrüktif ve Estetik Cerrahi Bölümü, Ankara, Türkiye

AMAÇ: El yanıkları sıklıkla oluşan ve sonuçları kişinin günlük bakım fonksiyonlarını, çalışma hayatını, istihdamı, serbest zaman etkinliklerini ve genel sağlıkla ilgili yaşam kalitesini önemli ölçüde etkileyen travmalardır. El yanığı travmalarında genel amaç, el fonksiyonunu optimize etmektir. El fonksiyonlarının rehabilitasyonu ve restorasyonu; hastanın bağımsızlığı, topluma ve işine yeniden entegrasyonu için kritik öneme sahiptir.

GEREÇ VE YÖNTEM: Bu çalışmanın amacı, yanık merkezimize başvuran ve tedavi edilen 105 el yanığı travmalı hastayla ilgili deneyimimizi sunmak ve erken rehabilitasyonun hastaların önceki sosyal yaşamlarına ve işlerine dönme yetenekleri üzerindeki etkinliğini göstermektir.

BULGULAR: Çalışmamıza 2017-2021 yılları arasında Gülhane Eğitim Araştırma Hastanesi yanık merkezinde yatarak tedavi gören 105 akut ciddi el yanığı travması olan hastalar dahil edildi. Hastalara her gün seanslar halinde rehabilitasyon programı uygulandı. El yanığı olan hastalar hareket açıklığı (ROM), kavrama kuvveti, Cochin El Fonksiyon Ölçeği (CHFS) ve Michigan El Anketi (MHQ) ile taburculuktan 12 ay sonra değerlendirildi. Parmakların aktif hareket toplamı ortalaması >180 derece idi. Dominant elin kavrama kuvveti ortalama değerleri erkeklerde 27.2±9.3 kg, kadınlarda 22.0±8.8 kg, erkeklerde dominant olmayan el kavrama kuvveti 24.05±13.8 kg, kadınlarda ise 17.8±10.3 kg idi. CHFS'de 5 maddenin toplam puanı 19.0 idi. MHQ'daki ortalama toplam puan 62.3±27.4 idi. Elde edilen tüm veriler normal veya kabul edilen fonksiyonel aralıklar içindeydi. Spearman korelasyon katsayısı, MHQ ile CHFS arasında negatif bir korelasyon olduğunu göstermektedir (p<0.01).

TARTIŞMA: El yanığı travmalarından sonra hastaların optimal fonksiyonlarını yeniden kazanmalarına yardımcı olmak için kapsamlı rehabilitasyon programına erken dönemde başlanmalıdır.

Anahtar sözcükler: Travma; el; rehabilitasyon; yanık.

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