

# Effects of early versus delayed excision and grafting on the return of the burned hand function

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**Background:** Despite a general consensus regarding the impacts of early excision and grafting (EE and G) of burned hand on the reducing of treatment cost and hospital stay, there are some controversial issues about its effect on the outcome of hand function. This study conducted to compare the results of the EE and G and delayed skin grafting in deep hand burns regarding the hand functional outcome. **Materials and Methods:** This study was conducted from April 2012 to November 2013 in sixty patients with deep thermal burns of the dorsal hand with total body surface area (TBSA) <20% who were admitted to special burn hospital. After standard primary burn care and resuscitation, necessary procedures (EE and G or more conservative treatment) were performed based on the patients' conditions. The patients were placed into early excision (No. =30) and delayed excision group (No. =30). Total active motion (TAM) of fingers, grip strength of the hand and the assessment of disabilities of the arm, shoulder and hand questionnaire, were measured in all patients 6 months after grafting. **Results:** The average percentage of TBSA in the EE and G group was more than the delayed excision group (17.34% ±5.12% vs. 15.64% ±5.83%), this difference was not significant ( $P = 0.23$ ). After 6 months, the average of the TAM and grip strength in the EE and G group was significantly more than that of the delayed group ( $P < 0.0001$  and  $P = 0.019$ ). **Conclusion:** The present study showed that EE and G with proper physical therapy and rehabilitation management provides a higher functional outcome in dorsal deep burned hand.

**Key words:** Active motion of fingers, burned hand, early excision and grafting, grip strength, hand function

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## INTRODUCTION

Hand burns are major injuries according to the American Burn Association, although each hand represents <3% of total body surface area (TBSA)<sup>[1]</sup> hands are involved in more than 80% of extensive burn injuries.<sup>[2,3]</sup> Their functions are the most important factors for the independence of humans in daily life activities.<sup>[4]</sup> Deep hand burns are the most disabling burns which cause dysfunction in the routine activities. Hence, the impact of the hand burns can be significant on function, appearance, and quality of life.<sup>[5,6]</sup>

It is well-established that superficial burns heal spontaneously without surgical intervention.<sup>[4]</sup> In these

cases, hypertrophic scar formation is very rare, and the functional outcome is good.<sup>[7,8]</sup> However, conservative management of deep hand burns results significantly in a higher deficiency of hand function versus active surgical treatment.<sup>[9]</sup> About 50 years ago, the idea that early excision and grafting (EE and G) is the method of choice for treating hand burns was being supported only by some burn surgeons.<sup>[8,10]</sup> At present, there is a general consensus in the most authorized burn centers in the world about early excision and skin grafting as a standard and preferred technique which could reduce the costs and length of hospital stay in acute deep burned hand injury, when there is no contraindication.<sup>[11,12]</sup> Effect of EE and G on the outcome of hand function is still controversial.<sup>[13,14]</sup> Does the EE and G of deep partial thickness hand burns increase the functional outcome of the hand more efficient than delay excision and grafting?

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Therefore, the present prospective observational study is conducted to compare function of the deep partial thickness burnt hands using the measurements of total active motion (TAM), grip strength of hand, and the assessment of disabilities of the arm, shoulder, and hand (DASH) questionnaire within the groups with different surgery times (EE and G vs. delayed skin grafting).

## MATERIALS AND METHODS

### Study design and participants

This study was performed over 1 year from April 2012 to November 2013 with the mean follow-up duration of 6 months. We included adult patients aged 10–60 years old with thermal burn of hand from April 2012 to May 2013 and finally chose sixty patients with deep thermal burns of the dorsal hand who had the inclusion criteria. The exclusion criteria were unstable conditions (multiple traumas, comorbidities, and serious inhalation injuries), hand burns due to electrical, chemical, or contact causes need flap covering or finger amputation, and history of previous upper extremities disabilities were excluded from this study. Because the EE and G is now the standard care of burns, it is morally unacceptable to select some patients for delayed excision when there is no clear contraindication for EE and G. Hence, we did not design to divide patients into early excision group and delayed excision group initially. Selection of the patients for the EE and G or delayed excision of hand was based on patients' condition. In the subjects with wound infection, in some extensive burn cases, or when there was difficulty in getting patient's decision for surgery at the proper time, delayed excision was inevitably selected.

### Procedures and variables

The following protocol was followed for all patients who were admitted with a thermal injury of hand. On admission to the emergency ward, after primary survey and obtaining secure vascular access, complete systematic trauma evaluations was done. Then, all the patients underwent a secondary survey, which included an assessment for the presence or absence of inhalation injury, estimation of TBSA burn, and primary clinical evaluation for the burn depth. In all cases with burns of more than 15%, fluid resuscitation was performed on the 1<sup>st</sup> day after the injury. In the circumferential burns of the hand, an escharotomy was carried out if indicated. The burn depth was determined again on the 2<sup>nd</sup> day after the injury by experienced burn surgeons. Appropriate night splinting of the hand was used to reduce the risk of joint contracture.

All the procedures in both groups were implemented by the same expert burn surgeons. In the early excision group, surgery was carried out in the 1<sup>st</sup> week after the injury. All the operations were performed under general anesthesia.

Tangential excision was conducted for deep split-thickness burns and prefacial excision for full-thickness burns superficial to the extensor paratenon. The Goulian and Watson dermatomes were applied to perform tangential excision. Facial excision was achieved by electrocautery. Autografts were applied immediately after excision in the early excision group. In the delayed excision group, only after enough wound debridement or spontaneous separation of eschar and preparation of proper granulation tissue, skin grafting was applied. In both groups, sheet grafts with the thickness about 0.5 mm were placed transversely to prevent contracture. In all of the cases, web spaces were reconstructed properly. Controlling blood loss was achieved by using sponges soaked in warm 1:50,000–1:100,000 adrenaline solution and no tourniquets were applied.

The first dressing of graft was usually changed on the 4<sup>th</sup> day after the operation. Physical therapy including both active and passive exercises was gradually started as soon as possible in the 2<sup>nd</sup> postsurgery week. As needed and based on the standard guidelines, individualized splinting, and rehabilitation were done in both groups.

In the follow-up period, measurements of TAM of each finger of the involved hand (TAM),<sup>[15]</sup> grip strength of the hand, and assessment of DASH<sup>[16]</sup> questionnaire were performed for all the patients 6 months after grafting. All the examinations were done by the same investigator who was blind to the patient's group.

### Total active motion

The percentage of normal TAM of each finger was obtained by dividing the TAM of each burnt finger by the TAM of the contralateral uninjured finger or normal value. Patients were placed in four groups based on the measurements. Excellent: Percentage of TAM is normal (100%), Good: percentage of TAM is >75%, Fair: Percentage of TAM lies between 50% and 75%, Poor: percentage of TAM is <50%.<sup>[15]</sup>

### Grip strength

Jamar dynamometer (Model J00105 Lafayette Instrument Co., USA) was used to measure the handgrip strength of grafted hand using the standard instructions described by Mathiowetz *et al.*<sup>[17]</sup> The procedure was done while the subject was seated on a chair, the arm hanging by the side, the elbow in 90° flexion, and the forearm and wrist in neutral rotation. For measuring the maximum isometric strength of the hand, the patients were encouraged to squeeze the maximum force on the handle for 3 s. The average result from three attempts was recorded in kilogram force. Considering the effects of age, gender, and hand dominance on the grip strength, the average of the measurements was expressed as the percentage of the expected norms of adult grip strength.

### Disabilities of the arm, shoulder, and hand

Patients' ability to do certain upper limb activities was evaluated using the Iranian version of 30-item status, the DASH self-report questionnaire.<sup>[16]</sup> The DASH has been tested and approved in terms of construct validity and internal reliability in the Persian language by Mousavi *et al.*<sup>[18]</sup> No additional optional modules were used. The patients were asked to rate their ability to do daily life activities in the last week by circling the appropriate number on a five - point scale ([1] no difficulty;[2] mild difficulty;[3] moderate difficulty;[4] severe difficulty;[5] unable).<sup>[15]</sup> Scores, ranging from 30 to 150 points, were transformed into a 0–100 scale using the formula [(score-30)/1.20]. A score of 0 means no disability and 100 means the most severe disability.<sup>[16,19]</sup>

### Statistical analysis

The Statistical Package for Social Science (SPSS Inc., Version 16, Chicago, IL, USA) was used to do the statistical analyses. For quantitative data, mean and standard deviation (SD) are used, and its normal distribution is done according to KS test. To evaluate the differences between two groups, independent *t*-tests were used for continuous variables. The difference between the two groups was significant if the *P* ≤ 0.05.

## RESULTS

There were thirty patients in each group. No significant differences were found between two groups in terms of sex, mean age, and dominant hand involvement distribution (*P* > 0.05). Although the average percentage of TBSA in the early excision group was more than the delayed excision group (17.34% ±5.12% vs. 15.64% ±5.83%), this difference was not significant (*P* < 0.05). Furthermore, Results shows statistically significant differences between both groups in the time intervals between burn injury and grafting, hospital stay, and treatment costs [Table 1].

After 6 months, the average of the total active motion of grafted fingers in the EE and G group was significantly more than that of the delayed group (*P* < 0.05) [Table 2].

The average of grip strength as a percentage of the expected norm was 71.8% ±18.3% in the EE and G versus 62.7% ±12.7% in the delayed group, which was significant (*P* = 0.019) [Figure 1].

The mean DASH-score and standard deviation for all the patients (sixty subjects) were 14.7 ± 7.5 (range of 0–20.8). Description of the collected DASH questionnaire data is demonstrated in Table 3. There were no significant differences between the two groups in this regard (*P* > 0.05).

**Table 1: Comparing variables in both early and delayed excision groups**

Variables	Early excision group (n=30)	Delayed excision group (n=30)	P
Age (years)	33.3±10.9	31.6±11.2	0.55
Gender (%)			
Male	25 (83)	27 (90)	0.70
TBSA (%)	15.64±5.83	17.34±5.12	0.23
Burn of dominant hand (case)	11	12	1.00
The mean number of burned fingers in each involved hand	2.76±1.83	2.51±1.95	0.61
Time intervals between burn injury and grafting (days)	3.42±1.48	7.59±1.12	<0.0001
Hospital stay (days)	8.56±5.18 <sup>‡</sup>	12.9±6.9	0.008
Treatment costs (USD)	1445.31±303.72 <sup>‡</sup>	2154.62±491.39	<0.0001

<sup>‡</sup>days. Significant *P*≤0.05; Nonsignificant *P*>0.05. TBSA=Total body surface area; USD=United States dollar

**Table 2: The average±standard deviation total active motion of fingers in two groups, 6 months after grafting**

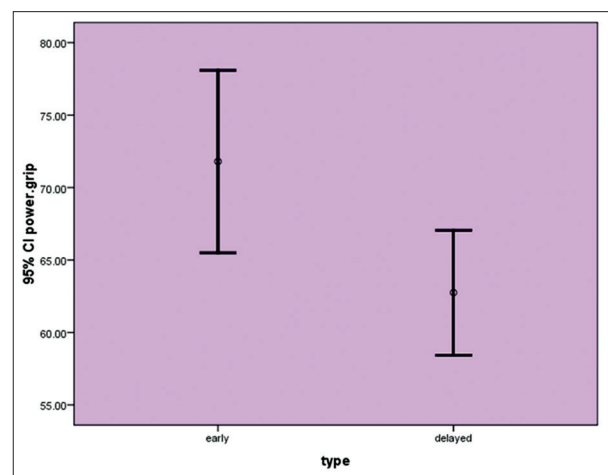
Digits	Early excision group (%)	Delayed excision group (%)	P
Thumb	118.3°±5.8° (94.6)*	105.5±11.7° (84.4)*	<0.0001
Index	242.2°±11.6° (93.1)*	216.2°±9.8° (83.1)*	<0.0001
Middle	249.2°±10.4° (95.8)*	225.1°±10.6° (86.5)*	<0.0001
Ring	240.7°±12.2° (92.5)*	216°±13.9° (83)*	<0.0001
Little	241°±12.8° (92.6)*	215.5°±12.4° (82.8)*	<0.0001

\*Percentage. Significant *P*≤0.05; Nonsignificant *P*>0.05; Percentage of normal range of motion

**Table 3: The average±standard deviation disabilities of the arm, shoulder and hand scores in two groups, 6 months after grafting**

	Early excision group	Delayed excision group	P
Mean±SD	13.5±7.5	16±7.4	0.198

SD=Standard deviation



**Figure 1: The average of grip strength as a percentage of the expected value**

## DISCUSSION

Returning the ability of the hand to perform daily activities is the most important goal in care for deep hand burns. Reliable hand function tests are necessary for evaluating the effectiveness of this treatment. There are many hand function tests;<sup>[15,16]</sup> but, there is no general consensus among the clinical and scientific burn authorities regarding the domain of hand function should be assessed and the best measurement manner of domains.<sup>[20]</sup> Although patients with burn injuries have hand function characteristics which are different from those of the patients with other diagnoses but there are no burn-specific hand function measures for burn injury patients yet.<sup>[20]</sup> However, some studies have demonstrated that assessing the range of motion (ROM) by a goniometer is an accurate measure in the burn population. Furthermore, reliability and validity of the Jamar dynamometer have been reported and it is considered the “gold standard” in grip strength measurement.<sup>[20-24]</sup> Therefore, these available hand function measures were selected to evaluate hand function outcome in this study.

Six months after grafting, the results of ranges of motion and grip strength measures were significantly better in the EE and G group, but there were no significant differences between the two groups in terms of the results of DASH questionnaire.

The present results regarding ROM and grip strength measures were in accordance with those of the studied that used these objective tests to assess burned hand functional outcome after grafting.<sup>[9,12,24,25]</sup> In contrast to our findings, some of the previous studies had concluded that there was no statistical difference in hand function outcome regardless of the initial treatment.<sup>[23,26]</sup> Probably, increasing the experience of burn surgeons in term of doing the EE and G has led to better results in hand function outcome in recent years compared to the previous years.

A recent randomized controlled trial by comparing the results of DASH in the groups has concluded that there is no statistically significant difference between the groups regarding “function, scar formation, daily activity limitation, and overall satisfaction.”<sup>[13]</sup> Moreover, no significant difference was found regarding the average  $\pm$  SD DASH scores between the two groups. This finding should not lead us to the conclusion of Mohammadi *et al.*,<sup>[13]</sup> research because the patient-reported outcome measure such as the DASH is not an objective test. The quick DASH was validated as an appropriate tool for measuring the quality of recovery after upper limb burn injury.<sup>[27-29]</sup> It has only 6-items; therefore, the hand function information obtained through the quick DASH may not be sufficient for in-depth assessment of hand functionality.<sup>[20]</sup> On the

other hand, there is not a strong correlation between the DASH score and TAM as well as grip strength measures,<sup>[16]</sup> probably due to insufficient sensitivity of the DASH for evaluating burn hand function outcome.

The present results were supported by a recent study published in 2011.<sup>[25]</sup> The work by Omar and Hassan was inconsistent with the findings of van Zuijlen *et al.*<sup>[4]</sup> In both studies, the Jensen–Taylor hand function test (JTHFT) was used to assess the hand burns outcome. Unlike the findings by van Zuijlen *et al.*,<sup>[4]</sup> in Omar and Hassan<sup>[20]</sup> study the time taken to complete the JTHFT test in the EE and G group was statistically and significantly shorter than that of other groups. The data of the recent study showed a clear relationship between the operation time after burn injury and the long-term hand function. These findings demonstrate that the EE and G is more efficient than conservative treatment in returning the hand function. The results of a retrospective analysis,<sup>[30,31]</sup> confirmed that the early surgical treatment of deep hand burns significantly reduced readmissions for secondary reconstructive procedures. Indeed, early surgery leads to the best hand function results and thus, those less secondary readmissions for corrective procedures are needed compared to the more conservative strategy.

In the present findings, like the studies by Maslauskas *et al.*,<sup>[9,12]</sup> despite the better results in the EE and G group, functions of the hands were not fully restored. Although early burnt hand excision and grafting appear to yield better results in hand function than delayed excision, it should be emphasized that physical therapy and rehabilitation management are indispensable for increasing the quality of hand functional outcome.<sup>[26,31]</sup> There were some limitations in the study. The main problem was a lack of randomization. The randomization of the study was not possible because it was morally unacceptable to deprive some patients from EE and G when there was no clear contraindication. The worse outcome in delayed excision group may be due to this bias.

## CONCLUSION

The EE and G approach and timely complementary therapies provide a higher functional outcome in deep burned hand. The present study provided further reliable documents that an EE and G approach to deep hand burns is a valid treatment and can cause significant improvement in hand function. In the end, whenever there are no contraindications, the EE and G of burned hand is a gold standard treatment.

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**Conflicts of interest**

There are no conflicts of interest.

**AUTHORS' CONTRIBUTION**

- SHS contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.
- MJF contributed in the conception of the work, drafting and revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.
- MS contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.
- MN contributed in the conception of the work, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.

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