

Eyebrow Restoration in Deep Facial Burn: Follicular Unit Extraction Hair Transplantation after Nanofat Graft

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Background: Eyebrows play an important role in protecting the eyes, and also transmit facial expression. Restoration of eyebrow loss after deep thermal burns is a challenging task because a scarred recipient area may affect the success rate of the hair transplantation outcome. Trials to improve this outcome via preparation of pretransplantation recipient area are mandatory.

Methodology: Seventeen patients (20 eyebrows) with partial or total postburn eyebrow loss were recruited. Nanofat injection was done as a preparatory step before hair transplantation. Patients were followed up monthly for 6 months after follicular unit extraction. The outcome was assessed both objectively by phototrichoscopy and patient satisfaction, and by incidence of complications.

Results: The mean eyebrow density of the recipient side was found to be 88.60 ± 29.96 hair follicle per cm^2 , compared with 133.95 ± 38.38 on the control side. The mean eyebrow thickness of the recipient side was found to be 0.07 ± 0.01 mm, compared with 0.06 ± 0.01 on the control side, The overall satisfaction was 60% regarding the density, 80% regarding direction, and 65% regarding symmetry. However, when it comes to texture, 45% were satisfied.

Conclusions: Restoration of eyebrow loss after deep facial burn is a challenging procedure. Improving the recipient area before hair transplantation is recommended to achieve a satisfactory outcome. Waiting until maturation of the scarred tissue of the recipient area and preparation of it with nanofat can achieve a satisfactory outcome. (*Plast Reconstr Surg Glob Open* 2023; 11:e5331; doi: [10.1097/GOX.0000000000005331](https://doi.org/10.1097/GOX.0000000000005331); Published online 11 October 2023.)

INTRODUCTION

Burns remain one of the main modes of trauma around the world, despite social and economic development. Eyebrows represent one of the most important facial features, with functional and aesthetic roles: they not only protect the eyes from forehead perspiration and bright sunlight, but also act as a key for facial expressions, indicating happiness, sadness, or surprise, for example. Loss of the eyebrows results in dire consequences to the patient both physically and psychologically, and their restoration constitutes a huge challenge.¹

Various techniques were described for restoration of eyebrows, either in the form of pedicled scalp flaps,

composite grafts, or hair transplantation. The use of pedicled scalp flap based on superficial temporal artery has many advantages, including being a simple procedure with compatible flap thickness, perfect texture, and color match that provides satisfactory results for the patients. However, potential visibility of the scar remains the main limitation of using this flap, in addition to the difficulty to match hair direction in some cases.^{2,3}

Hair transplantation can be performed in postburn loss of eyebrows, being the gold standard method for treatment of alopecia. One of the main challenges of hair transplantation in postburn patients is the scarred recipient site. This, in turn, might cause unsatisfactory results due to poor tissue perfusion, tissue fibrosis, and infection, which can jeopardize the survival of hair grafts.⁴⁻⁶

Adipose tissue has regenerative capability, which aids in enhancing the healing of the severed tissue. This is due to numerous growth factors such as basic fibroblast growth factor, insulin like growth factor 1, and many others included in the stromal vascular fraction of nanofat.

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Adipose tissue is also rich in adipose-derived stem cells, which are progenitor cells with the ability to differentiate into other types of tissues. Using nanofat in improving the quality of postburn scars has been approved by many studies.⁷⁻⁹

As hair transplantation in cases of cicatricial alopecia has unsatisfactory results, the aim of the authors was to address the effect of the nanofat injection in scarred tissue before follicular unit extraction (FUE) hair transplantation to restore eyebrows in patients with postburn loss of eyebrows.

METHODOLOGY

In this prospective case-series study, 17 adult patients (20 eyebrows) with old, deep thermal burn (flame and scald) of the face of 12 months duration or more were enrolled. All patients had eyebrow loss, either unilateral or bilateral, partial or total. Recent burns of less than 12 months duration, other modes of burns (eg, chemical and electrical burns), patients with hypertrophic scars, and keloid of the recipient areas were excluded. Signed written informed explanatory consent was obtained from all the patients before enrollment. None of the patients had comorbidities or had been taking long-term medication at any given period in their life, apart from the hospitalization period for the burns they had encountered.

I. The Procedure:

The procedure was done in two stages; the first one was nanofat injection to the skin of the eyebrow, and the second stage was hair transplantation using the FUE method 3 months after the fat injection session.

First Stage: Nanofat Injection at the Scarred Skin:

The fat was harvested from the lower abdomen under general anesthesia. Injection of 200 mL tumescent solution (Klein formula) to the donor area was done. Fat was harvested using a 3-mm harvesting cannula that was connected to a 20-mL syringe. Negative pressure was created by pulling the plunger of the syringe backward. After the fat harvesting step, the fat was washed to get rid of blood and local anesthesia. The fat was then transferred to a 10-mL syringe and left to be decanted for 30 minutes. The upper and lower layers were discarded, and the middle layer was used for injection. The next step of fat emulsification was done via 30 manual passes of the fat between two syringes. Then filtration was done using three metal filters (0.5, 0.3, and then 0.15 mm). Subdermal and intradermal nanofat injection was administered in a fanning pattern into the recipient area of the future hair transplantation, with a 1-mm diameter metal cannula connected to a 3-mL syringe. After fat transplantation, the patient was advised to sleep with head-up position for 1 week to minimize edema. The patients were then followed up in a weekly visit until the end of the first month and then monthly until the end of the third month.

Second Stage: FUE Hair Transplantation

FUE hair transplant from the posterior scalp to the eyebrow was performed under local anesthesia. Grafts

Takeaways

Question: How to improve the outcome of the eyebrow hair transplantation after old deep facial burns? Will nanofat injection before the hair transplantation improve results with good patient satisfaction score?

Findings: Proper timing of the hair transplantation to eyebrows with preparation of the scarred recipient tissue with nanofat injection will improve hair transplantation outcome, with minimal complications and good satisfactory outcome.

Meaning: To obtain satisfactory outcome in hair transplantation in postburn patients, you should wait until the scarred recipient tissue becomes a mature scar with no hypertrophic or keloid scarring, and preparatory nanofat injection before hair transplantation is recommended.

were harvested by motor-power-assisted punches (0.75 or 0.85 mm). After graft harvesting, recipient area was prepared using a microblade. Slits of 1.2 to 1.3 mm in diameter were created in the recipient area in a random pattern. Follicular hair units were then implanted into slits using a micro-forceps. Antibiotics and analgesic were given for 1 week postoperative. Topical minoxidil was also prescribed for 3 months. Graft take was assessed 3 and 6 months posttransplantation for observing the final results.

II. Postprocedure Assessment:

In a trial to get the most accurate results, patients were assessed using both objective and subjective methods.

1. Quantitative analysis of transplanted hair:

A tricoscope was used to generate phototrichograms; digital computerized software was used to measure the hair density per cm² and hair thickness (in millimeters), supported by a microviewer (Model DLite, STR company, Felton, Calif.).

2. Subjective assessment:

Postoperatively, patients were asked to assess time needed for hair to be trimmed in days, the need to repeat the transplantation procedure, the need to camouflage the transplanted eyebrow with makeup, and likelihood to recommend this procedure to others.

Moreover, the patients were asked to complete the survey of satisfaction, and questions were about the density of transplanted eyebrow, symmetry between the transplanted and control eyebrow, and texture compared with control side. The patients were asked to give a score from 1 to 5: five points being extremely satisfied, and one point being extremely unsatisfied.

Furthermore, patients were assessed by a control panel of three plastic surgeons who were not involved in the procedure. The surgeons were asked to give a score of 1–5 regarding the symmetry, direction, texture, density, and need to redo the procedure. An average of their results was calculated and sent for statistical analysis. Posttransplantation complications were assessed by

incidence of folliculitis and/or donor site complications in the form of alopecia or infection.

III. Statistical Analysis:

All data were collected, tabulated, and statistically analyzed using SPSS 26.0 for Windows (SPSS Inc., Chicago, Ill.). Quantitative data were expressed as the mean \pm SD (range), and qualitative data were expressed as absolute frequencies (number) and relative frequencies (percentage). Independent samples Student *t* test was used to compare between two groups of normally distributed variables.

All tests were two sided. A *P* value less than 0.05 was considered statistically significant; A *P* value greater than or equal to 0.05 was considered statistically insignificant.

RESULTS

The studied group included 17 patients (20 eyebrows). Regarding sex distribution of patients, 15 were women (88.3%) and two were men (11.7%). The age range was 18 to 26 years, with a mean of 21.7 ± 2.7 . All patients had postburn brow hair loss, most commonly flame burn [15 patients (88.3%)], while the remaining two patients (11.7%) had scald burn.

The mean eyebrow density of the recipient side was found to be 88.60 ± 29.96 , compared with 133.95 ± 38.38 on the control side, a statistically significant difference with *P* less than 0.001. However, the mean eyebrow thickness of the recipient side was found to be 0.07 ± 0.01 , compared with 0.06 ± 0.01 in the control side, a difference that was not found to be of any statistical significance since the *P* value was 0.129. Furthermore, the mean hair thickness of hair from the donor site was 0.07 ± 0.01 compared with 0.07 ± 0.01 for eyebrow hair thickness in the recipient site. Those results were again not found to be statistically significant, as the *P* value was 0.534.

Regarding the clinical outcomes, patients reported a need to trim their transplanted eyebrows every 5–14 days, with a mean value of 9.15 ± 3.22 . Moreover, six patients (30%) needed to repeat the procedure, and the same number reported the need to camouflage. Nevertheless, all of the study group were inclined to recommend the procedure to others with the same condition.

As for the satisfaction survey, observers reported 90% satisfaction rate (ranging between 65% satisfied and 25% very satisfied) regarding hair density; 65% regarding hair direction (ranging between 40% very satisfied and 25% satisfied); 55% for symmetry (20% very satisfied and 35% satisfied); and finally, 60% satisfaction for the texture.

The patient satisfaction survey showed 60% overall satisfaction regarding the density (40% very satisfied and 20% satisfied), 80% regarding direction (15% very satisfied and 65% satisfied), and 65% regarding symmetry (35% very satisfied and 30% satisfied). However, when it comes to texture, 30% of the patients were not satisfied and 45% were satisfied.

In this study, none of the patients developed folliculitis, and only four patients (20%) had donor site complications

in the form of mild infection, which was managed by topical antibiotics.

The results are illustrated in Figs. 1–3, showing magnified phototricoscopy pictures of the transplanted eyebrow and control (normal) eyebrow. Pre- and post-transplantation standard photographs are illustrated in Figures 4–7.

DISCUSSION

Facial burns represent a quarter to one-third of burn cases worldwide. Due to the vile effect of burns on facial features, burn stigma can have dire effects on the individual's quality of life, both physically and psychologically. One of the stigmata of postburn injuries to the face is unsightly scarring and cicatricial loss of the eyebrows. The eyebrows play an important role not only in the aesthetic appearance of the patients and their self-image, and subsequently their self-confidence; they also have a protective role, and their loss can cause functional and cosmetic dilemma, represented mainly in the loss of transmission of emotions that aids in daily social interactions. All these facts make eyebrow restoration one of the most demanding, yet inevitable challenges that should take a priority when deciding on postburn patients' management plan.

Various methods were described for camouflage of eyebrow loss. These include superficial temporal-artery-based scalp flaps, composite grafts, and hair transplantation using either follicular unit transfer or FUE.

FUE is the gold standard method for restoration of hair loss in cases of alopecia, as it is a simple procedure that can be done under local anesthesia with minimal donor site morbidity and no additional scars to the donor site. It is suitable for eyebrow restoration, as only a few grafts are needed to be transferred. The second reason that makes this our preferred method is that many facial burn patients have simultaneous scalp affection with resultant cicatricial alopecia. This is why the authors were keen to avoid additional scars to the scalp.

The main obstacle to achieve satisfactory outcomes after hair transplantation in those patients is the scarred recipient area, which may affect the hair graft take. So, our aim was to address how to improve the outcome and achieve satisfactory results. In our study, 17 patients (20 eyebrow) with either partial or total, unilateral or bilateral eyebrow loss as a sequelae of deep facial burns were included. The procedure was done in patients with mature scars of more than 12 months of burn injury to ensure that the scar was stable, and all patients with hypertrophic or keloid scarring were excluded. A preparatory step of nanofat injection 3 months before hair transplantation was done.

Many studies describe the role of fat injection to improve the quality of the skin condition in postburn patients.^{7,10} One of these studies was the study published by Jan et al.⁷ They addressed the effect of nanofat injection on postburn skin, and they concluded that fat injection has satisfactory results in improving the scar quality. This is because nanofat is a rich source of stem cells and

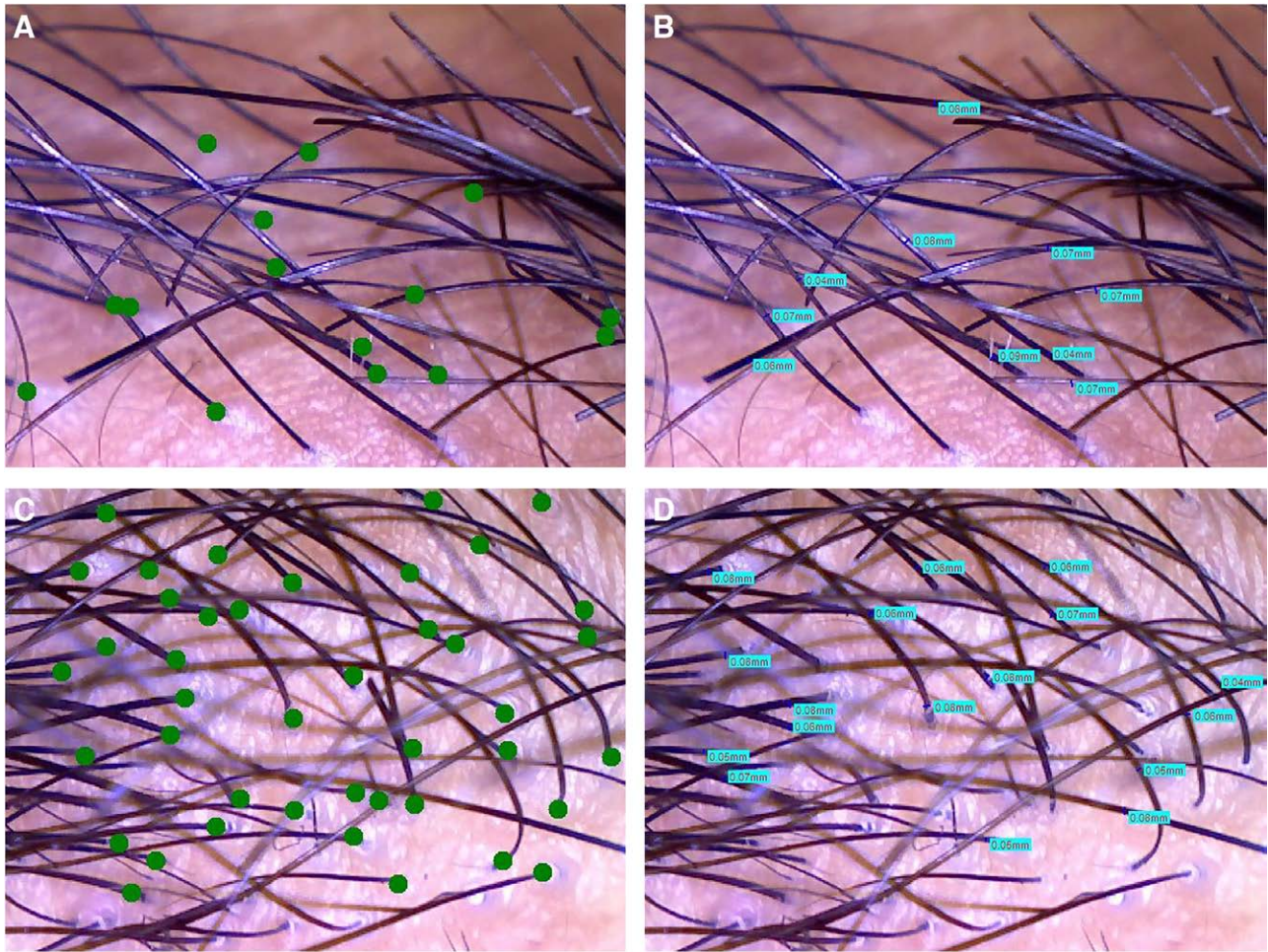


Fig. 1. A, Density of the terminal hair in recipient eyebrow: 52/cm². B, Hair thickness in recipient eyebrow (0.04–0.09 mm). C, Density of terminal hair in control eyebrow: 188/cm². D, Hair thickness in control eyebrow (0.01–0.09 mm).

other growth stimulating factors with minimal donor site morbidity. Preparation of nanofat in the current study was prepared by fat emulsification by passing it between two syringes, and then filtration was done using a 0.15-mm metal filter to facilitate fat injection using a small-sized cannula. Jan et al⁷ used nanofat after emulsification with no further filtration to fat with satisfactory postprocedure results. Other authors prepared nanofat through emulsification and then filtration using nylon gauze.⁸

Then, hair transplantation was performed using FUE in all patients. Grafts were taken by 75 to 85-mm punch. Patients were followed up for 6 months after transplantation. Both subjective and objective methods were used for evaluation of the outcome. Phototricogram is used for objective assessment of the results. It is a safe, reproducible, noninvasive method that can help ascertain the quality and quantity of the transplanted hair. After taking a magnified photograph of the treated area, the number of the terminal hairs in cm² was calculated and can be accurately compared with the control/normal eyebrow. Although, after hair transplantation, the density of the transplanted eyebrow was statistically lower than that of the control (133.95 ± 38.38 terminal hairs per cm² in control versus 88.60 ± 29.96 in recipient eyebrow),

patients with a density of more than 70 terminal hairs per cm² were satisfied with the results. The second objective analysis parameter was the hair thickness. The thickness was compared between the recipient versus control/normal eyebrow to address how the transplanted eyebrow simulates the normal one regarding hair thickness. Mean thickness of the recipient eyebrow was 0.07 ± 0.01 mm versus 0.06 ± 0.01; the difference was statistically insignificant. Also, the difference in thickness between the donor site (scalp) and the recipient (eyebrow) was compared 6 months after transplantation to address whether the hair shaft will maintain its natural anagen thickness 6 months after transplantation or not. The range of donor area thickness was 0.05–0.09 mm with a mean thickness of 0.06 ± 0.01 mm versus 0.06–0.09 mm with a mean thickness of 0.07 ± 0.01 mm. The difference was statistically insignificant.

Regarding the clinical outcome, the patients need to trim their transplanted hair between 5 and 14 days with a mean of 9 days. Six patients (30%) were not satisfied regarding the density and still need to use makeup to camouflage the difference in density and need a second session to achieve a satisfactory density. All of our patients would recommend the procedure to others.

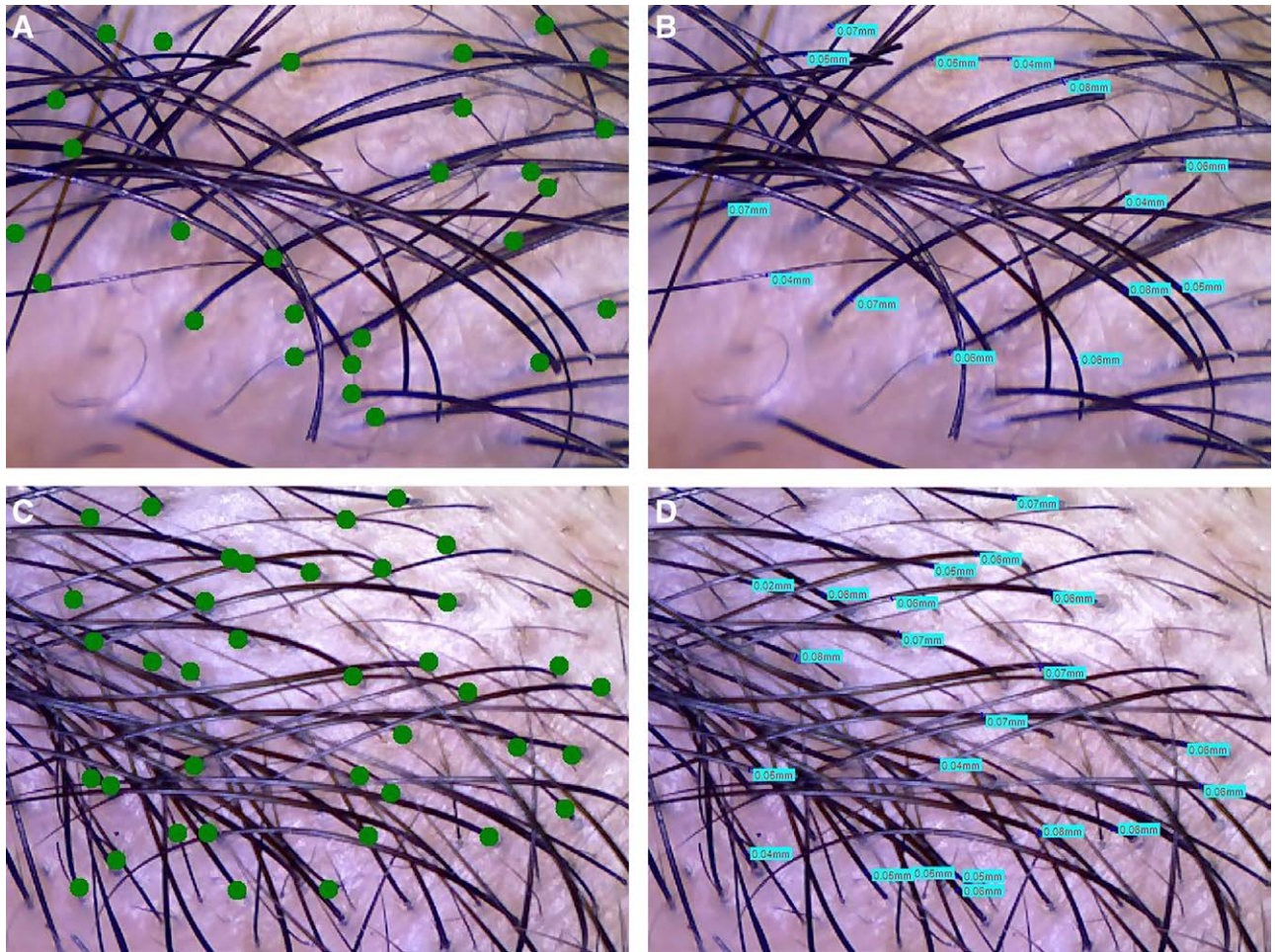


Fig. 2. A, Density of the terminal hair in recipient eyebrow: 88/cm². B, Hair thickness in recipient eyebrow (0.04–0.07 mm). C, Density of terminal hair in control eyebrow: 127/cm². D, Hair thickness in control eyebrow (0.02–0.08 mm).

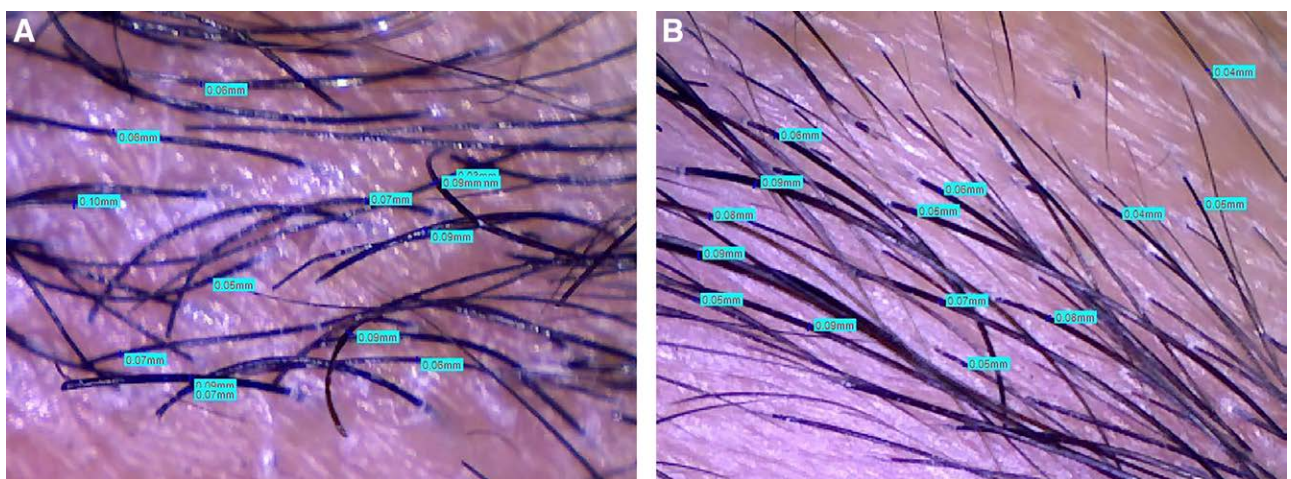


Fig. 3. A, Hair thickness in recipient eyebrow (0.04–0.09 mm). B, Hair thickness in control eyebrow (0.01–0.09 mm).

Regarding patients' satisfaction, they answered a simple questionnaire about their opinion regarding the texture, symmetry, density, and direction of growth of hair. Sixty-five percent were satisfied with density, 60% were

satisfied with texture, and 40% were neutral. Regarding symmetry, 55% were satisfied and 45% were neutral, and 80% were satisfied with the direction of hair growth. Our patients were assessed by a panel of plastic surgeons

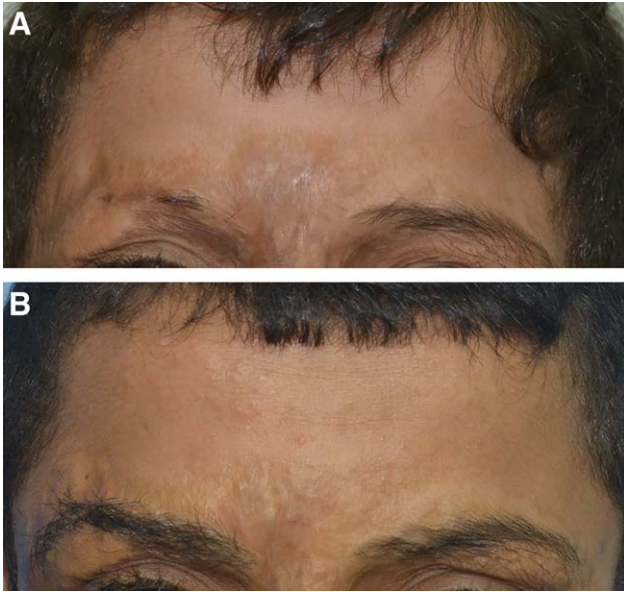


Fig. 4. A, An 18-year-old male patient with right eyebrow hair loss. B, Six months post hair-transplantation, he is satisfied regarding density and texture.



Fig. 5. A, A 24-year-old female patient with partial right eyebrow loss. B, Nine months post hair-transplantation, she is satisfied regarding density and texture.

who were not involved in the study. They assessed the density, texture, symmetry, and direction of hair growth. Regarding density, the satisfaction score was 90%, texture satisfaction was 60%, symmetry was 55%, and direction was 65%.

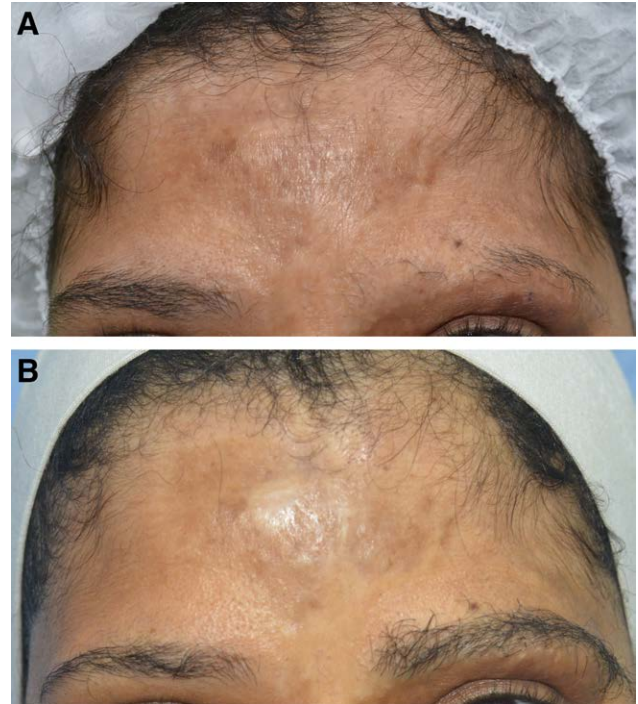


Fig. 6. A, A 20-year-old woman with partial loss of left eyebrow. B, Six months posttransplantation, she is satisfied regarding density and texture.

No patients developed recipient site complications (eg, folliculitis), whereas four patients complained of donor site minimal infection that was resolved after topical antibiotic application. In a recent study by Al Husiny et al in 2022, follow-up of postburn patients with transplanted eyebrows was done through documenting patient satisfaction, the number of grown hair follicles that were counted under magnification, hair density, symmetry, direction, and rate of complications. Follow-up of the patients was documented by means of photographs. On statistical analysis, 40% of the cases reported very good results, 20% yielded good results, 15% of cases had fair results, and 25% had bad results.¹¹

Another study published in 2015 by Rajput et al stated that the hair growth from transplanted grafts in burned eyebrows is delayed; 30%–40% of grafts grow in 5–6 months, another 40% grow in 7–8 months, and the last 10% grow in 8–10 months. The authors also stated that only 9% of their patients could be corrected in a single stage, whereas 77% required another stage and 14% required three stages for satisfactory results.¹²

LIMITATIONS

One of the limitations of our study is the lack of a control group, which could allow us to accurately compare the effect of nanofat in increasing the take of the graft and to determine whether this difference is statistically significant or not. The other limitation was the difficulty in accurately measuring the percentage of graft take, as the graft includes more than one hair follicle (two to three),



Fig. 7. A, A 19-year-old woman with bilateral partial loss of eyebrow. B, Six months posttransplantation, she is satisfied regarding density and texture.

and the postoperative photographs were used to assess the terminal hair density.

CONCLUSIONS

Restoration of eyebrow loss after deep facial burns is a challenging procedure because a scarred donor site may negatively affect the transplanted graft take. Preparation of the recipient area to minimize scarring and improve the quality of skin is a recommended step before hair transplantation.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

Patients provided written consent for the use of their images.

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This study was approved by the ethical committee of our institute, and conducted in accordance with the Declaration of Helsinki of 1975.

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