Int J Clin Exp Med 2017;10(1):774-780
www.ijcem.com /ISSN:1940-5901/IJCEM0037241

Original Article

Scalp soft tissue expansion combined with follicular unit extraction for postburn cicatricial alopecia: a single center experience of 48 patients

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Received August 4, 2016; Accepted September 22, 2016; Epub January 15, 2017; Published January 30, 2017

Abstract: *Purpose:* This case series aimed to evaluate the efficacy of a composite reconstructive surgery combining scalp soft tissue expansion (SSTE) with follicular unit extraction (FUE) in the treatment of post-burn cicatricial alopecia. *Methods:* From June 2006 to July 2010, 48 patients (32 males and 16 females, mean age 23 years, including 3 pediatric patients) with postburn cicatricial alopecia who were treated by scalp alopecia reconstruction (SSTE and FUE) were enrolled. The procedure was divided into three stages. Stage I involves the insertion of the expander into the scalp and its expansion to at least 2 fold of the original scarred area. In stage II, the original scarred tissues were excised and local flaps transfer repair (LFTR) was conducted to cover the defect. In stage III, FUE was applied to cover the unmulched scars, hairline or the residual defect. *Results:* A total of 38 patients participated in the stage III of the scalp alopecia reconstruction. During the follow-up of 2-5 years, the outcomes were described as excellent in 23 patients (60.5%) and good in 14 patients (36.8%), whereas one patient (2.6%) was lost to followed-up. Three patients (6.25%) developed complications in scalp soft tissues expansion, including 1 case of infection and 2 cases of wound dehiscence. *Conclusion:* The combination of SSTE and FUE was a powerful and effective approach for post-burn cicatricial alopecia.

Keywords: Scalp soft tissue expansion, follicular unit extraction, postburn cicatricial alopecia, hair restoration

Introduction

Cicatricial alopecia is one type of hair loss and has led to an increasing risk of psychosocial and psychiatric conditions, as well as some diseases such as prostate cancer and squamous cell cancer of the scalp [1]. The most prominent characteristic is that the hair follicle is destroyed and replaced by fibrous tissues [2]. Among various kinds of cicatricial alopecia, postburn alopecia has severe aesthetic and psychological implications and remains the most difficult challenges for dermatologists, because the etiopathogenesis is not completely understood and there is no best therapy approach [3, 4].

The existing treatments for cicatricial alopecia include reduction techniques, hair grafting, hair transplantation and skin extension, as well as tissue expansion techniques [5-9]. Tissue expansion is the most commonly applicable surgical therapy owing to the advantages of providing large hair-bearing scalp tissue with acceptable hair density, confidence without long waiting time for graft growth, and facilitating primary closure of the donor sites [10-12]. However, the surgical procedure is usually accompanied by unexpected, displeasing and unnatural aesthetic outcomes [13]. Additionally, the alteration in the direction of the hair growth in the tissue expansion is also an inevitable complication [14] for the patients. Hair transplantation is the other commonly used treatment (using micropunch technique, slit technique and laser assisted method) for male pattern baldness and it can provide satisfied defect removing and density improvement [15]. However, a poor blood circulation bed and the time-consuming procedures make postburn cicatricial alopecia difficult to be treated [16, 17].

In recent years, follicular unit extraction (FUE) as an alternative donor harvesting technique

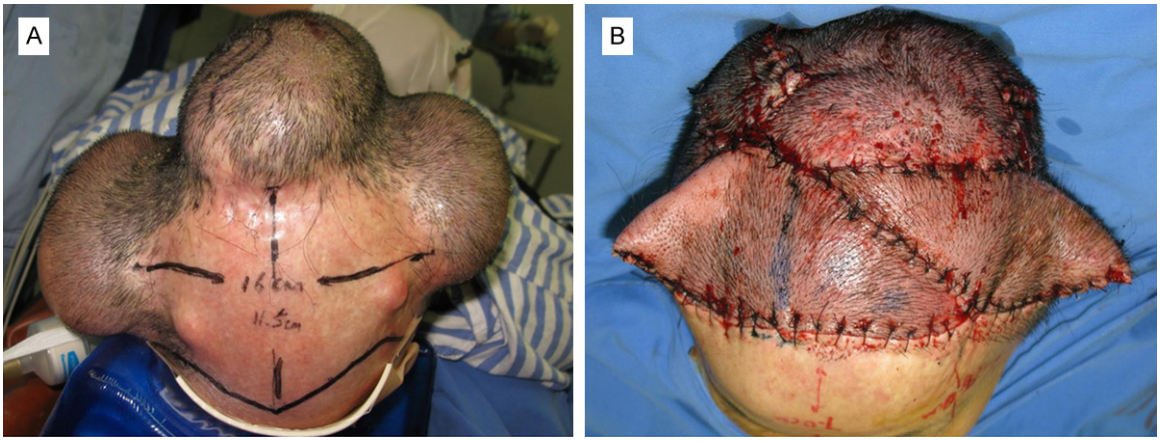

Figure 1. Hair reconstructive surgery for a male patient with parietal defect: the planning (A) and exact placement (B) of the hair grafts.

has been more frequently performed in hair transplantation, during the procedure of which small punch excisions are used to individually harvest follicular units from the donor area [18]. It is considered to be a minimally invasive hair transplant method [19], and allows hair transplantation to be performed with the absence of a distinct linear scar and less postoperative pain [20]. However, FUE also has some disadvantages, such as increased surgical times, limited follicular units from donor area for transplantation one time, graft fragility and increased cost to the patient; besides, lower graft survival with FUE for less protective tissue around the graft follicles must also be taken into consideration [21]. Thus, it was hypothesized that tissue expansion with FUE would decrease the need for follicular units and obtain well cosmetic outcomes.

Our homeochronously conducted case series have combined soft tissue expander with FUE to reconstruct cicatricial alopecia caused by burning and achieved good satisfaction [22]. This case series further evaluated the efficacy of scalp soft tissue expansion (SSTE) with FUE and postoperative complications. It would add to the growing experiences and bring further support to the feasibility and effectiveness of tissue expansion with FUE for postburn scar alopecia in clinical practice.

Materials and methods

Patients

From June 2006 to July 2010, a total of 48 patients (32 males and 16 females, mean age 23 years, range from 5-37 years, including 3 pediatric patients) who were diagnosed with postburn cicatricial alopecia and treated by scalp alopecia reconstruction: SSTE with FUE in our department were enrolled in this case series. Anyone who had a family history of androgenic alopecia (AGA) was excluded. Temporal (n = 21) and parietal (n = 15) parts were the most common alopecia sites. The size of alopecia ranged from 22.5 cm^2 to 156 cm^2. This research protocol was approved by the Ethics Committee of our hospital and the written informed consents were obtained from all patients.

Scalp soft tissue expansion

Soft tissue expanders (Eurosilicone, Apt, France) with various shapes (rectangular, crescent and elliptical) and volumes (100 mL, 150 mL and 300 mL) were chosen based on the size of the scarred area. The internal port valves of all the expanders were placed at a certain distance to avoid accidental punctures during the injections. This operative procedure of scalp alopecia reconstruction consisted of three stages. In stage I, an incision was made within the border of the scarred area under general anesthesia. After a carefully performed hemostasis, expanders were inserted at 0.5 cm from the juncture of the scarred area and normal scalp. The hair line should be avoided as far as possible. Then, the expanders were immediately inflated with physiological saline at 10%-20% of the expander's volume using a 30-G needle to achieve better hemostasis. A suction drain was always placed in the pocket in every case.

Figure 2. A 17-year-old boy with post-burn scalp alopecia (120 cm^2) on the frontotemporal and parietal regions (A) underwent scalp soft tissue expansion (SSTE) and follicular unit extraction (FUE). One rectangular (100 mL) and two crescent (150 mL) expander were located to the adjacent hairy temporal-occipital zone (B); the alopecic defect was mostly recovered by expanded rotation-advancement flaps (C); vertical images of the patient immediately after FUE for residual defect (D); anterior and lateral images of the patient 3 years after FUE (E, F).

Thereafter injection at 10% of the expander's volume was performed 7 d after surgery and proceeded with 3 d interval until the expanded area was at least 2 fold of the scarred area (**Figure 1A**). In stage II, the expander was kept for 4 weeks and then removed following the excision of the original scarred tissues. Local flaps transfer repair (LFTR) was conducted to cover the defect (**Figure 1B**). As to stage III, the residual defect which was unmulched with local flaps or the LFTR-induced tensive scars along the incision, were camouflaged using the FUE method one year after stage II. In addition, the hairline was reconstructed if possible. Although tissue expansion in the pediatric patient was derived from the same rationale as in adults, treatment of the children was more difficult than the adults because children usually had poor psychological response. Hence, free psychological consult was offered to the pediatric patients.

Follicular unit extraction

On the day of the surgery, the occipital hair in the entire donor area was shaved to 1-2 mm in length to ensure adequate visualization of the direction of hair entry into the scalp and direction of the hair bulb [23]. Patient was placed in a prone position on an operating table, and a folliscope was used to measure hair density and hair shaft diameter to calculate the amount of follicular units for transplantation. Subsequently, local anesthesia (lidocaine diluted with

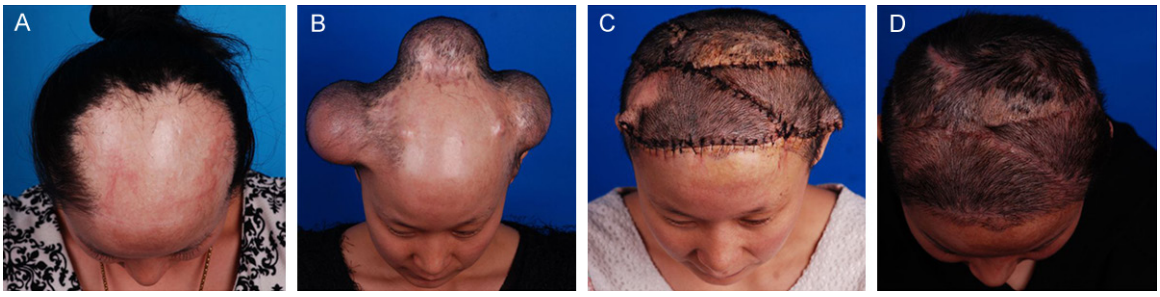

Figure 3. A female patient with post-burn scalp alopecia on the frontotemporal and parietal regions (A) underwent SSTE and FUE. Three expanders were located to the adjacent hairy temporal-occipital zone (B); the alopecic defect was mostly recovered by expanded rotation-advancement flaps (C); vertical images of the patient 1 month after taking stitches out (D).

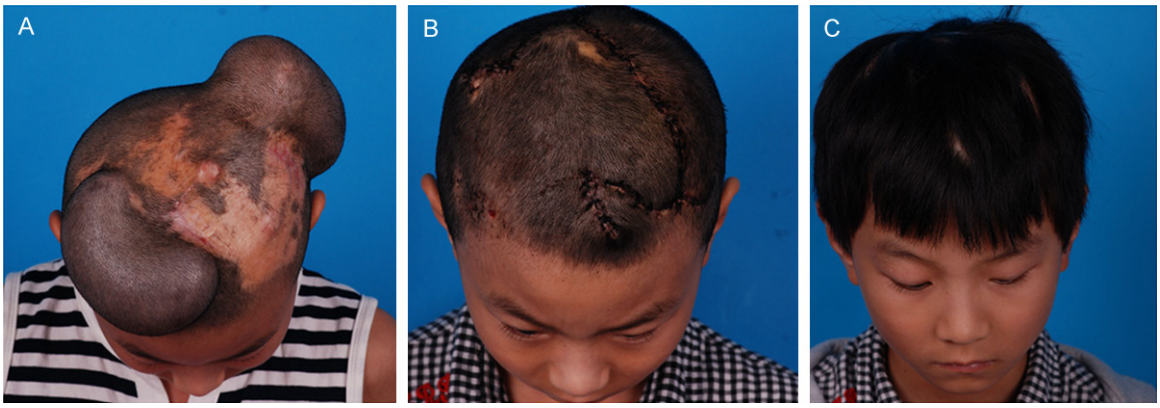

Figure 4. A pediatric patient with post-burn scalp alopecia on the temporal and parietal regions underwent SSTE and FUE. Two expanders were located to the adjacent hairy frontal-occipital zone (A); the alopecic defect was mostly recovered by expanded rotation-advancement flaps (B); vertical images of the patient 2 years after FUE (C).

normal saline) was administered slowly over the entire donor area [24]. The grafts, mainly from the occipital scalp due to the fewer androgen receptors in the occipital hair follicles and the following less androgenic loss [21, 25], were then extracted from the donor area using 1.0 mm special micropunches. The procedure of follicular unit extraction was performed under 2.5 × magnifications.

Using the sharp side of the micropunch, the scalp skin containing the follicular unit was scored. Then, the dull side of the punch was twisted in the same area to loosen the follicular unit. At the same time, an assistant countertraction was applied to facilitate the penetration of the punch inside the dermis. Then the graft was gently removed using forceps after the removal of the punch, and preserved in cool ringer lactate solution for transplantation. Finally, the recipient site was prepared with needles and grafts were transplanted in the desired pattern with an implanter.

Follow-up

Patients were followed-up after stage-III surgery. Efficacy of the soft scalp soft tissues expansion and FUE was assessed by patient-reported-outcomes (PRO) as excellent, good, fair and poor.

Results

During the stage I of scalp alopecia reconstruction, a total of 71 expanders were placed in 48 patients. Since the end of stage II, 6 patients obtained satisfactory outcomes and thus did not continue the following stage-III surgery; other 3 patients were attributed to their economic concerns. Among the remaining 39 patients, one patient quitted the case series since the implants were infected. Hence, 38 patients participated in the stage III of the scalp alopecia reconstruction. During the follow-up of 2-5 years, excellent aesthetic results were achieved in 23 patients (60.5%, **Figures 2**-**4**)

and good in 14 patients (36.8%), whereas one patient (2.6%) was lost to followed-up. Three patients (6.25%) developed complications in scalp soft tissues expansion because of the inadequate regulation of the expander's volume and excessive scalp tension of expanded donor area, including 1 case of infection and 2 cases of wound dehiscence.

Discussion

Since its first introduction in 1957, soft tissue expander has been applied in various types of surgeries, such as burn operation and plastic surgery, and it obtains great success both in aesthetic surgery and reconstructive procedures [26, 27]. The advantages of soft tissue expander are numerous; for instance, it provides an excellent tissue match for defects [28]. Nevertheless, the complications associated with soft tissue expander are also controversial. Previously, a report by Qing *et al.* showed that 14% of total 57 patients developed a complication [29]. Similarly, Saleh *et al.* also reported a complication rate of 21.5%, with 8.25% infection and 5% expander extrusion [30]. In our case series, the complication rate was 6.25% (3/48), with 2% (1/48) infection and 4.25% (2/48) wound dehiscence, which was lower than the above studies. This was attributed to our rich experience in the application of soft tissue expander and the immediately injection of physiological saline using a 30-G needle, with particular emphasis on adequate draining after surgery for hematomas. All the procedures of SSTE and FUE procedure were completely performed by the physicians. Additionally, the application of FUE might lead to the necrosis of the donor area of a patient who underwent the hair restoration with FUE [31]. In our case series, all the patients who underwent the combined reconstructive surgery did not experience this kind of complication. Hence, it seemed that the combination of tissue expansion and FUE decreased the complication.

Composite reconstructive surgery for postburn cicatricial alopecia addresses an unmet clinical need in cosmetic hair reconstructive surgery. Tissue expansion and hair transplantation make full use of the advantages of each technique. It not allows large scarred areas to be covered by tissue expansion but also maintains the natural appearance of hair transplantation. In our case series, 37 patients with the postburn scalp alopecia were recovered using this method. However, it takes more cost and longer time (about one year) to achieve satisfactory outcome or complete recovery than the routine or single therapy because of the hair growth cycle. Patients have to suffered more pain from hair implantation at scarred areas than generally unscarred areas, owing to the tension of scarred area. On the other hand, it is not suitable for the patients with AGA or a family history of AGA. Besides, we do not recommend patients with a family history of AGA to do strip transplantation after multiple flap procedures for indistinct 'safe zone'. But in scarring alopecia covered with skin grafts, it is not suitable for hair transplantation but the excision and replacement by composite skin containing hair would be better. If the defect area just covered the 'safest' zone, patients should decide which procedure to take to cure the alopecia.

Several limitations have been noted in our study, such as the short length of follow-up. Besides, there were no definitive criteria used to establish the rating system for the categories of outcomes. The lack of objective and reliable indexes made a further study with a longer follow-up needed to assess the effectiveness of tissue expansion with FUE for postburn scar alopecia.

Our experiences with composite hair reconstructive surgery offered a fast redistribution of hair to large burn areas, and maintained the ability to provide more finished and aesthetic outcomes using smaller numbers of individual grafts. Although objective and reliable indexes were lacked, good aesthetic results could be obtained by this approach.

Acknowledgements

This case series was supported by the science and technology projects fund of Hangzhou City (Grant No.: 20130633B04).

Disclosure of conflict of interest

None.

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