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ORIGINAL RESEARCH

Efficacy and Safety of Autologous Follicular Unit Excision in Pediatric Secondary Cicatricial Alopecia: A Retrospective Case Series

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Objective: To explore the efficacy of Follicular Unit Excision (FUE) in treating pediatric secondary cicatricial alopecia.

Methods: We selected 11 cases of patients under 18 years old who underwent treatment for secondary cicatricial alopecia at the Chengdu Hengmei Hair Medical Clinic from January 1, 2021, to December 31, 2022. Among them, there was 1 female and 10 males. All patients underwent FUE procedures. After 12 months, the assessment of the surgical efficacy was evaluated using the Global Aesthetic Improvement Scale (GAIS), and the incidence of complications was recorded.

Results: Among the 11 patients, none experienced complications such as infection, skin necrosis, significant hematoma, unnatural appearance, or temporary hair loss. 6 cases (54.5%) were rated as 1 on the GAIS, indicating extreme satisfaction. 2 cases (18.2%) were rated as 2, signifying satisfaction, resulting in an overall satisfaction rate of 72.7%. 1 case (9.1%) scored 3, showing limited improvement and dissatisfaction, and 2 cases (18.2%) scored 4, indicating no improvement.

Conclusion: FUE hair transplantation is a safe, minimally invasive, and effective method for treating stable cicatricial alopecia in children, leading to significant aesthetic improvements for the patients. Further studies with larger cohorts are needed to confirm these results and explore long-term outcomes.

Keywords: children, follicular unit excision, secondary cicatricial alopecia, global aesthetic improvement scale, GAIS

Background

Cicatricial alopecia is an irreversible form of hair loss, which includes primary cicatricial alopecia and secondary cicatricial alopecia. Primary alopecia occurs when inflammation or immune reactions directly attack the hair follicles, causing the follicle structures to be destroyed and replaced by fibrous tissue, which leads to permanent hair loss. For example, common types of primary alopecia in children include lichen planopilaris and central centrifugal cicatricial alopecia.[1] Pediatric secondary cicatricial alopecia often arises following head and facial surgeries, trauma, or burns, leading to permanent hair loss due to follicle damage. While this condition does not affect the patient's physical health or daily physiological activities, its impact on the patient's appearance poses a significant risk to their mental well-being[2] thereby interfering with their daily activities. Moreover, since children are in a developmental stage where their mental maturity is not yet fully formed, the impact is even more substantial. Hair loss in children may lead to increased levels of anxiety, depression, and social withdrawal, which can further interfere with their daily activities and overall quality of life.

Autologous follicular unit excision has become a common method for treating adult cicatricial alopecia due to its minimal damage, rapid recovery, natural postoperative results, and minimal scarring.[3] However, there are limited reports

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on its application in the treatment of cicatricial alopecia in children. Compared with other surgical treatment methods, such as scalp flaps or tissue expanders, FUE is a less invasive approach and has fewer complications associated with donor site morbidity. However, FUE demands higher surgical precision and experience, especially when dealing with pediatric patients.

This study reviewed and summarized the clinical experience of using FUE hair transplantation to treat cicatricial alopecia in children, assessing the surgical improvement using the Global Aesthetic Improvement Scale (GAIS).

Materials and Methods

Clinical Data

We selected 11 patients under the age of 18 who were treated for secondary cicatricial alopecia at the Chengdu Hengmei Hair Medical Clinic from January 1, 2021, to December 31, 2022. Among them, there was one female and ten males, with ages ranging from 14 to 17 years and an average age of 16.2 years.

Inclusion criteria: (1) Stable cicatrices for at least 1 year; (2) No itching, pain, or persistent chronic inflammation in the cicatrices and surrounding scalp; (3) Adequate healthy follicles available for transplantation; (4) Patients and guardians understanding the surgical risks and potential outcomes; (5) Normal cognitive function, communication ability, and mental state, good compliance, and ability to cooperate with the surgery and postoperative follow-up.

Exclusion criteria: (1) Patients with significant organ diseases, blood system disorders, or malignant tumors; (2) Unstable hair loss patients; (3) Individuals with a keloidal tendency.

All patients underwent their first surgery and received routine preoperative examinations, including complete blood count, coagulation profile, electrocardiogram, and infectious disease screening. This study followed the Declaration of Helsinki, obtained informed consent from the guardians and their patients with signed written consent forms, and received approval from the Ethics Committee of Chengdu Hengmei Hair Medical Clinic.

Surgical Procedure

(1) Preoperative preparation: Discontinuation of medications such as aspirin for one week before the surgery, completion of relevant examinations, and exclusion of contraindications. The "pinprick test" was used to assess the blood supply in the scarred area. If there was bleeding at the puncture site, it indicated good blood supply and suitability for surgery. Specific procedures are detailed in this article[4] Designing the measurement of the transplant area and assessing the required number of follicular units, and cleansing the scalp.

(2) Donor Hair Harvesting: The patient is positioned in a seated position for anesthesia, exposing the donor-dominant area at the occipital region, and draping the area with sterile towels. The anesthetic mixture consists of 15 mL of 2% lidocaine injection, 10 mL of ropivacaine injection, 50 mL of normal saline, and 0.35 mL of 0.1% adrenaline. Following successful anesthesia, a tumescent solution is injected, comprising 100 mL of normal saline and 0.5 mL of 0.1% adrenaline. Subsequently, the patient is positioned in a lateral or prone position for follicular unit excision, using a harvesting device manufactured by Xi'an Xingmao Co., Ltd., China, with a rotation speed of 1500–2000 rpm.

(3) Follicular Unit Preparation: When isolating the follicular grafts, excessive meticulousness is not necessary. Each graft is required to have intact follicles with sebaceous glands, a small amount of surrounding tissue, and adipose tissue, providing the graft with some nutritional support.[5] Arrange them neatly in a solution of compound sodium chloride at 0–4°C. Handle with care throughout to avoid damaging the follicles and prevent dehydration and necrosis of the grafts.

(4) Recipient Site Implantation: The scarred area is routinely disinfected, and local tumescent anesthesia is administered using 2% lidocaine and a small amount of adrenaline. The adrenaline content should not be excessively high, as this can lead to compromised blood supply in the scarred area, affecting the survival of the grafts. Using a 0.6–0.9mm injection needle, create punctures in the designated areas according to the preoperative plan, aligning the puncture direction with the original hair growth direction. Pay attention to the natural hairline, implanting single and double follicles in a sequential manner from the anterior to posterior, maintaining a sense of hierarchy.

Whenever possible, aim for single-session implantation to avoid repetitive insertion, which can damage the follicle bulbs, and take precautions to prevent contamination of the grafts during the procedure.

(5) Postoperative Care: Apply moist dressings with Kangfu Xin solution to the donor area, cover it with dry gauze, and then apply pressure bandaging. Remove the bandage after 24 hours. The recipient area should remain uncovered, and care should be taken to avoid friction on the transplanted hair. Oral antibiotics should be taken to prevent infection, and it's important to avoid spicy foods, as well as alcohol and tobacco.

Observation Indicators

a. Twelve months post-operation, the patient and their family will evaluate the results using the Global Aesthetic Improvement Scale (GAIS), with the following specific scoring criteria: 1: Very much improved, 2: Much improved, 3: Improved, 4: No change, 5: Worse. The satisfaction rate is calculated as the number of cases with GAIS scores of 2 or less divided by the total number of cases, multiplied by 100%.
b. Incidence of complications, including infection, skin necrosis, significant hematoma, unnatural appearance, and temporary hair loss. The incidence rate is calculated as the number of occurrences divided by the total number of cases, multiplied by 100%.

Statistical Methods

Statistical analyses were performed using R4.3.2 (http://www.R-project.org, The R Foundation) and Free Statistics software version 2.0. Descriptive statistics are presented as numbers and percentages of patients, or as mean values and standard deviations.

Results

Hair Transplant Evaluation: Patient demographics are detailed in Table 1. There were a total of 11 cases, comprising 10 males and 1 female. Among them, 10 were of Han ethnicity, and 1 was of Tibetan ethnicity. The causes of scar formation included surgery, burns, and accidental trauma. The average affected balding area was 26.5 cm2 (range 2–112 cm2), with an average of 942 follicular units (range 77–3850 FUs). All patients underwent a single surgery, with an average duration of 2.8 hours (range 0.67–7.67 hours).

All 11 patients did not experience any infections, skin necrosis, significant bruising, unnatural appearance, or temporary hair loss complications. The relationship between patient and family GAIS scores and complications is shown in Figure 1, with no instances of GAIS=5, indicating a worsening aesthetic outcome compared to preoperative conditions.

Figure 1: Relationship between Patient and Family GAIS Scores and Complications: Among them, 6 cases (54.5%) had a GAIS score of 1, indicating a high level of satisfaction with the outcome, good survival of transplanted hair in the recipient area, high coverage, and natural aesthetic. 2 cases (18.2%) had a GAIS score of 2, indicating satisfaction, resulting in an overall satisfaction rate of 72.7%. 1 case (9.1%) had a GAIS score of 3, indicating limited improvement,

Table 1 Basic Characteristics and Surgical Information

Number	Age	Sex	Ethnic	Cause of Injury	Transplanted Grafts (FUs)	Size (cm^2)	Hours	Area
1	17	Male	Han	Surgery	203	5	1.33	Nape
2	17	Male	Han	Surgery	576	16	2.33	Right temple
3	17	Male	Han	Burn	2707	76	6.67	Frontal
4	16	Male	Han	Accident trauma	630	17	2.25	Left temple
5	17	Male	Han	Accident trauma	115	3	1	Left temple
6	16	Male	Han	Accident trauma	408	10	1.92	Vertex
7	14	Male	Han	Surgery	303	9	2	Nape
8	16	Male	Han	Surgery	1293	36	3.67	Right temple and vertex
9	16	Male	Han	Accident trauma	77	2	0.67	Frontal
10	15	Male	Tibetan	Burn	3850	112	7.67	Vertex
11	17	Female	Han	Accident trauma	196	5	1.83	Vertex

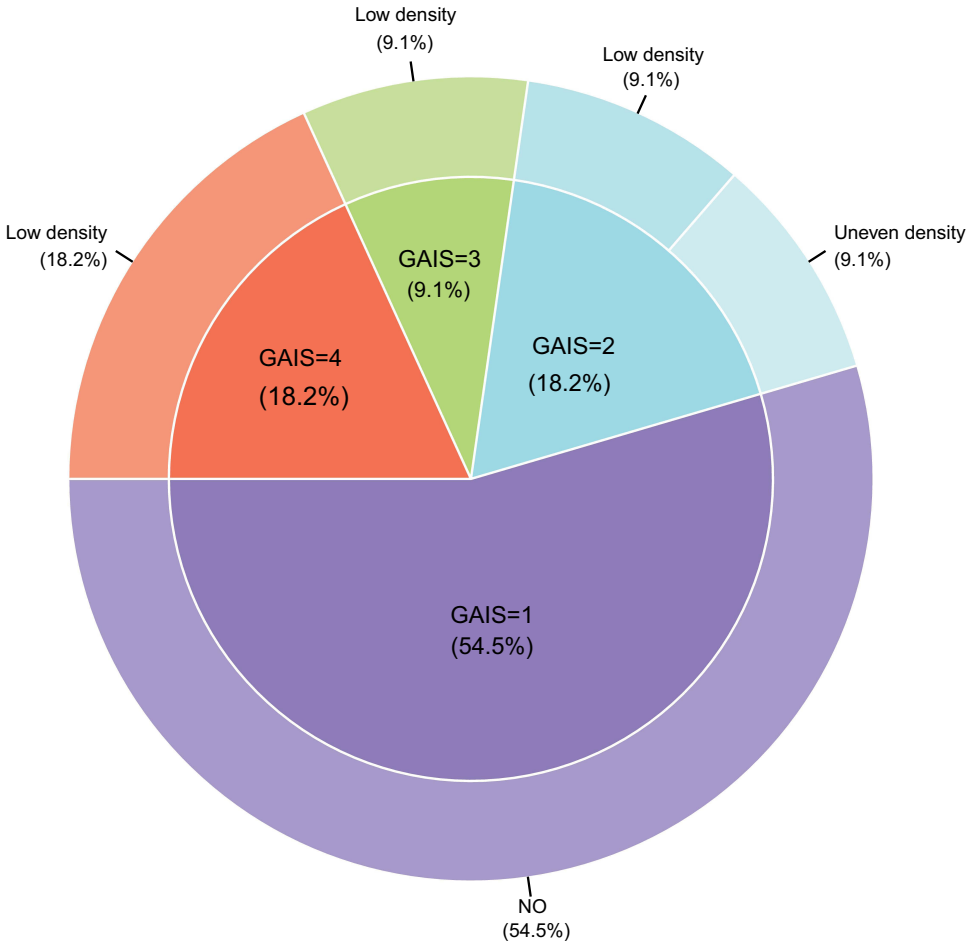

Figure 1 Relationship between Patient and Family GAIS Scores and Complications.

expressing dissatisfaction. 2 cases (18.2%) had a score of 4: "No change", with patients experiencing scarring alopecia due to surgery expressing extreme dissatisfaction. The main reasons for dissatisfaction were low hair density and lack of improvement in scarring.

Case: Male, 17 years old, presented with scarring alopecia on the forehead due to a burn, with an area of approximately 76 cm^2. A total of 2707 follicular units were extracted using the FUE technique, with a surgical duration of 6.67 hours. The patient and family GAIS score was 1 (Very much improved). Preoperative photos are shown in Figure 2A, and follow-up photos at 1 year postoperatively are shown in Figure 2B.

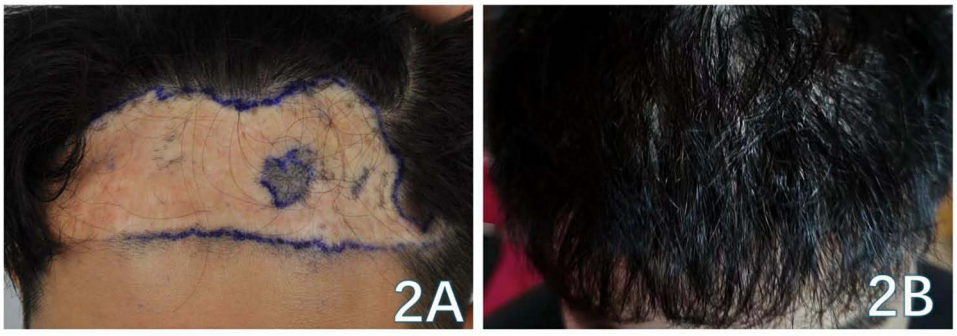

Figure 2 (**A**) Preoperative photograph. (**B**) Photograph at 1 year postoperatively, showing natural hair growth on the forehead.

Discussion

Pediatric stable scarring alopecia is a condition that significantly impacts the appearance and psychological well-being of affected individuals. Traditional treatment methods include scalp reduction surgery, flap reconstruction, and tissue expansion, each with its own advantages and disadvantages. For pediatric cicatricial alopecia, different treatment options can be selected based on the patient's condition. Scalp scars less than 20 cm^2 can be directly excised or repaired with local flaps. However, flaps can result in long incisions, leading to new scars that affect appearance. When the area is too large for local flaps to be sufficient for repair, tissue expansion is used. However, tissue expander surgery in children has some limitations due to the high number of surgeries required, long inflation cycles, additional scalp incisions, inconsistent hair growth directions, higher infection rates compared to adults, and difficulties in postoperative care cooperation.[6]

FUE hair transplantation, due to its minimal damage, rapid wound healing, natural postoperative hair growth, and discreet scarring in the donor area, is more readily accepted by patients. It can also be flexibly applied in irregular and scattered areas, making it more effective in the treatment of adult scarring alopecia. However, the physiological and psychological characteristics of children differ from those of adults. Therefore, exploring the application and effectiveness of FUE hair transplantation in the treatment of pediatric stable scarring alopecia is of significant clinical importance.

The GAIS is a subjective assessment tool used to evaluate the effectiveness of cosmetic treatments. It is a 5-point scale designed to measure the overall improvement in the appearance of the subjects before and after treatment. Historically, it has been widely used in clinical research in the field of dermatology, particularly in assessing the improvement effects of cosmetic devices such as radiofrequency and laser treatments on skin wrinkles, laxity, acne scars, and other conditions.[7–9] This study applies the GAIS to patients with scarring alopecia, allowing for the reflection of the patients' subjective experiences and making it suitable for psychosocial effect analysis.

The results of this study indicate that the satisfaction rate for FUE hair transplantation in treating pediatric stable scarring alopecia is 72.7%, suggesting that this treatment approach has achieved a relatively favorable improvement in appearance for the majority of patients. Its therapeutic mechanism may be associated with follicular unit transplantation inducing tissue regeneration and actively reshaping fibrotic tissue.[10] However, 18.2% of the patients and their families reported a GAIS score of 4, indicating that they perceived no change in the treatment effect. Further analysis of the reasons for dissatisfaction revealed that the primary cause of dissatisfaction in these cases of scarring alopecia was the scarring resulting from previous scalp surgeries. These surgical scars extended beyond the epidermis, reaching into the subcutaneous tissue, which hindered the normal development of hair follicles.[3,11] The scar tissue is notably firmer, with a texture tougher than normal scalp tissue, lacking healthy follicles and blood supply, thus limiting the ability for hair regeneration.[12] Previous studies have also found that the efficacy of hair transplantation in treating scarring alopecia caused by surgical incision scars is relatively poor, consistent with the results observed here.[13]

Therefore, the vascularity of the scar tissue is one of the key factors influencing the survival rate of transplanted hair. It is essential to assess the vascularity of the scarred area preoperatively and emphasize to the patient's family the possibility of unsatisfactory survival rates and the potential need for secondary surgery. During the surgical procedure, given that children have smaller hair diameters, shorter follicle lengths, and softer scalp tissue, it is crucial to employ precise surgical techniques, select appropriate follicle excision tools, and use suitable machine speeds to minimize damage to the donor area and disruption of follicular units. During implantation, due to the poorer vascularity of scarred tissue compared to normal tissue, reducing the use of adrenaline and appropriately lowering the hair implantation density is essential to ensure adequate blood supply.[14,15] Moreover, studies have shown that the structural characteristics of scars (both hypertrophic and atrophic) can also impact the postoperative outcomes.[16] Due to the firmness of scars, it is important to avoid squeezing the follicular units out of the scar tissue during punching, which is another factor contributing to low survival rates. This can be addressed by using needle implanters to assist with implantation or by employing electronic punch tools with a diameter of 0.6 millimeters to secure the transplantation space, thereby reducing the risk of graft extrusion and enhancing the success of the procedure.[17]

In the adult population, FUE hair transplantation typically involves local anesthesia, making it an outpatient procedure with a quick and safe recovery, which is one of its distinctive features. However, in the pediatric population, the use of local anesthesia depends on the patient's cooperation. In this study, the patients aged[14–17] demonstrated good cooperation, allowing for the use of

local anesthesia during surgery without any anesthesia-related issues. For younger children, procedures can be performed under general anesthesia by an anesthesiologist with extensive pediatric anesthesia experience, providing better support for the surgery.[12] Additionally, attention should be given to ensuring the safe dosage of anesthetic drugs to guarantee patient safety.

Furthermore, post-operative compliance with care instructions may also impact hair density. Children may not fully adhere to post-operative care instructions such as scalp cleaning and medication use, which could lead to graft dislodgement, folliculitis, and subsequently affect the outcome of the surgery. Therefore, the cooperation and guidance from the patient's parents are particularly crucial. It is important to thoroughly explain to parents the significance of post-operative care and provide specific care instructions, including scalp cleaning, medication use, and the avoidance of external trauma.[18] Regular follow-up and examinations are essential to promptly identify and address any potential issues. In addition, psychological support is also crucial. Children undergoing treatment may experience anxiety, low self-esteem, and other psychological issues. Healthcare professionals and parents should provide ample attention and support to help patients build confidence and alleviate psychological burdens.

This study still has some limitations. First, the sample size is relatively small. Second, for the issue of poor blood supply in scar tissue, further exploration of new treatment methods and technologies, such as the combined use of PRP, low-energy laser, and drugs to improve local blood circulation, could enhance the survival rate and density of hair transplants. Additionally, we observed positive changes in the patients' personalities and psychology due to the improvement in their appearance post-surgery. Therefore, designing psychological assessments to objectively evaluate the psychological changes in patients would be beneficial. Future research should involve larger sample sizes and more rigorous statistical analyses, and should be conducted as multicenter, prospective studies to further validate these findings and to better understand the long-term outcomes and potential complications associated with FUE in pediatric patients.

Conclusion

Follicular Unit Excision (FUE) hair transplantation is a safe, minimally invasive, and effective method for treating stable cicatricial alopecia in children, providing patients with significant improvements in their appearance. However, the small sample size and lack of statistical validation limit the robustness of our findings. Further studies with larger cohorts are needed to confirm these results and explore long-term outcomes.

Ethical Approval

The study was approved by the Ethics Committee of Chengdu Hengmei Hair Medical Clinic.

Consent for Publication

We have obtained consent from all patients and their respective guardians, and signed photographic consent forms for each patient.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article

has been submitted; and agree to be accountable for all aspects of the work. Yanchao Niu and Ling Zhu contributed equally to this work and share first authorship.

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Disclosure

All authors declare no conflicts of interest in this work.

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