




Application of Autologous Hair Transplantation Technique in Children with Cicatricial Alopecia

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ABSTRACT

Introduction: Cicatricial alopecia not only affects the appearance of children's heads and faces but also their mental health in the long term. This study aims to explore the therapeutic characteristics and clinical effects of autologous hair transplantation technology in children with cicatricial alopecia.

Methods: Children in our department who received autologous hair transplantation technology for cicatricial baldness of the scalp from February 2019 to October 2022 were collected. Their basic information was analyzed, and postoperative follow-up was conducted, including calculation of hair follicle survival rate, hair growth, complications, and an efficacy satisfaction survey given to the children's family members.

Results: Thirteen children were included in this study (10 males and 3 females), aged from

4 years 1 month to 12 years 10 months, with an average age of 7 years 5 months. Two hundred to 2500 hair follicular units were extracted, with an average recipient area of 22.7 cm², an average hair follicle unit density of 55.3 ± 9.1 per cm², and an average hair/follicular unit (hair/FU) ratio of 1.75 ± 0.07. Thirteen children in this group were followed up for 6–12 months with the following treatment options: FUE (follicular unit extraction, 9 cases), FUT (follicular unit transplantation, 3 cases), and FUT combined with FUE (1 case). The average hair survival rate was 85.3%. Except for one child with temporary folliculitis, there were no complications. The GAIS score is divided into five levels: complete improvement (2 cases), obvious improvement (10 cases), partial improvement (1 case), no improvement (0 cases), and deterioration (0 cases). The patient satisfaction results included very satisfied (2 cases), mostly satisfied (10 cases), and dissatisfied (1 case).

Conclusion: Autologous hair transplantation technology is a safe and effective method for children with cicatricial alopecia.

Keywords: Cicatricial alopecia; Children; Autologous hair transplantation technique

Jiping Wang and Jing Liu contributed equally to this work.

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Key Summary Points

Why carry out this study?

1. Cicatricial alopecia in children is a common problem after burn and plastic surgery and impairs children's lives and psychology.
2. At present, hair transplantation technology is widely used in adult hormone-related alopecia and cicatricial alopecia, but there are few reports on cicatricial alopecia in children.
3. This study aims to explore the therapeutic characteristics and clinical effects of autologous hair transplantation technology in children with cicatricial alopecia.

What was learned from the study?

1. Autologous hair transplantation technology, including follicular unit transplantation (FUT) and follicular unit extraction technique (FUE), can be used as a minimally invasive treatment for hormone-related alopecia and cicatricial alopecia in children.
2. If patients had residual "dog ear deformity" during surgery, we did not rush to repair it, but retained the deformity to provide hair follicle material for later hair transplantation.
3. Autologous hair transplantation technology is a safe and effective method for children with cicatricial alopecia.
4. It is important to explore the application of autologous hair transplantation in the treatment of cicatricial alopecia in children.

INTRODUCTION

Cicatricial alopecia in children is a common problem after burn and plastic surgery and impairs children's lives and psychology. Currently, surgical treatment is mainly used in clinic. For children at a special stage of growth and development, the traditional treatment is traumatic and causes linear scar baldness. Use of autologous hair transplantation technology, including follicular unit transplantation (FUT) and follicular unit extraction technique (FUE), has been widely used as a minimally invasive treatment method for hormone-related alopecia and cicatricial alopecia in adults but has rarely been reported in children. Therefore, it is important to explore the application of autologous hair transplantation in the treatment of cicatricial alopecia in children.

SUBJECTS AND METHODS

Ethics statement: This study conforms to the basic principles of the Helsinki Declaration and has been reviewed by the Ethics Committee of Beijing Children's Hospital Affiliated to Capital Medical University (Ethics Review Number: 2022-E-143-R). Patients signed informed consent regarding publishing their data and photographs.

This study retrospectively analyzed 13 patients (10 males and 3 females) treated with autologous hair transplantation for cicatricial alopecia in our department at Beijing Children's Hospital. Among them, one patient received two hair transplants because of unsatisfactory results, perhaps because the hair loss area in this patient before surgery was too large, and one operation could not achieve satisfactory results, so a second hair transplant was needed. The causes of cicatricial alopecia included six cases after head surgery, three cases after burns, and four cases after trauma (Table 1). Inclusion criteria were: (1) a cicatricial hair defect > 1 year old, sufficient donor origin; (2) no scar abnormal hyperplasia, no scar ulcer; (3) the patient could tolerate anesthesia and surgery. Exclusion criteria were: (1) abnormal liver and kidney

Table 1 Surgical and postoperative follow-up of 13 pediatric patients

Number	Gender	Age (months)	Defect area (cm ²)	Surgical method	Location	Cause of injury	Number of transplanted follicle units	Hair follicle unit density (/cm ²)	Survival rate (%)	Hair/FU ratio	GAIS scoring	Patient satisfaction
1	F	95	35	FUT + FUE	Frontal apex Front hairline	After repairing nevus with dilator	1000	45.5	96.1	1.69	Obvious improvement	Mostly satisfied
2	M	66	32	FUE	Frontal apex	Scald	2000	62.5	93.4	1.75	Obvious improvement	Mostly satisfied
3	M	125	25	FUE	Parieoccipital Temporalis	Accident trauma	1600	64	86.1	1.78	Obvious improvement	Mostly satisfied
4	M	154	8	FUE	Temporalis	Burn	350	44	95.8	1.74	Obvious improvement	Mostly satisfied
5	M	84	35	FUE	Frontal apex	Scald	2500	71	85.7	1.86	Obvious improvement	Mostly satisfied
6	F	49	20	FUE	Coronal suture	After craniostyostosis	1150	58	81.2	1.78	Obvious improvement	Mostly satisfied
7	F	73	25/20	FUE	Frontal apex	After repairing nevus with dilator	1400/1300	56/65	72/90.3	1.62	Partial improvement	Dissatisfied
8	M	90	3	FUE	Parieoccipital Occipital	Gouges	200	67	91.7	1.7	Obvious improvement	Mostly satisfied
9	M	95	20	FUE	Parieoccipital	Glass cut	1100	55	85.5	1.82	Obvious improvement	Mostly satisfied
10	M	119	14	FUT	Occipital	After repairing nevus with dilator	700	50	76	1.71	Obvious improvement	Mostly satisfied
11	M	68	32	FUT	Parieoccipital	After repairing nevus with dilator	1500	46.9	85.3	1.8	Complete improvement	Very satisfied

Table 1 continued

Number	Gender	Age (months)	Defect area (cm ²)	Surgical method	Location	Cause of injury	Number of transplanted follicle units	Hair follicle unit density (/cm ²)	Survival rate (%)	Hair/FU ratio	GAIS scoring	Patient satisfaction
12	M	84	16	FUT	Temporalis	After repairing sebaceous nevus with dilator	900	56.3	81.7	1.67	Complete improvement	Very satisfied
13	M	60	30	FUE	Paricoccipital	Accident trauma	1300	43	81.4	1.88	Obvious improvement	Mostly satisfied

function, abnormal coagulation function; (2) neuroalopecia; (3) > 2/3 of the area lost.

For individual children taking anticoagulants for a long time, their use should be discontinued 1 week before surgery. The child’s hair is shampooed the day before surgery and the hair at the donor site trimmed to 3 mm. The surgical area is marked and the degree of hair defects evaluated before surgery. The required number of hair follicle units is calculated.

Compared with FUT, FUE is a more common and less invasive method. In our study, children with narrow or scattered alopecia (9 patients) were treated using FUE technology (PK7000, LEADM, South Korea). However, if patients had residual “dog ear deformity” during surgery (3 patients), we did not rush to repair it but retained the deformity to provide hair follicle material for later FUT hair transplant surgery (shown in the supplementary figure). Besides the above methods, in one case a combination FUT and FUE technology was used because there was less tissue in the dog ear deformity. The surgery involves three basic steps: donor area preparation, transplant unit preparation, and transplant unit implantation.

Donor area preparation: The posterior occipital region was selected as the donor site for FUE transplantation in children. The FUT transplantation procedure used the remaining dog ear deformity area after the expanded skin flap as the donor area. The donor area was injected with 1% lidocaine solution combined with adrenaline hydrochloride (1:200,000) for local swelling.

We inserted a 0.6–0.8-mm circular drill in the direction of hair growth into the growing hair follicle in the posterior occipital region of FUE, paying attention to strength, depth, and speed. The density of perforations was not too dense, generally not exceeding 30/cm². The depth of the borehole was about 2–4 mm, ensuring that the borehole reached the aponeurosis outside the skull and avoided cross-cutting hair follicles. We placed the extracted hair follicles on saline gauze for later use. We cut the excised scalp into small strips in FUT.

Transplant unit preparation: We placed the hair follicles extracted by FUE technology or

small pieces of tissue obtained by FUT technology on a cold, damp, and sterile operating table. The hair shaft area was held with tweezers to avoid damage to the nipple area, and the excess epidermis and adipocytes around the hair follicle were removed under a 2× magnifying glass to prepare single, double, and triple hair follicle units. When separating them, we gently replaced the blade in time to avoid blunt injury to the tissue. The hair follicle units were arranged neatly and placed on cold, moist, sterile gauze. The operating platform temperature was strictly observed.

Transplantation unit implantation: We selected a 20-22G sharp needle and inserted it into the skin according to the direction and angle of hair growth in the recipient area, with a penetration depth of approximately 3–4 mm, to prepare corresponding micropores in the recipient area. The surgeon retracted the needle in the left hand while holding fine tweezers in the right to transfer the hair stem area of the unit and feed it into the bottom of the hole, trying to implant it at once to avoid hair follicle damage and more exposure caused by multiple insertions.

The recipient and donor areas were covered with Vaseline gauze for 3 days after surgery. We tried to prevent compression and scratching in the surgical area. Antibiotics were injected for 2 days after surgery to prevent infection (such as folliculitis), and the hair was washed 7 days after surgery.

In our study, 13 patients were followed up multiple times after surgery, with the shortest follow-up time being 6 months and the longest 12 months. Therefore, we chose 9 months after surgery as the time point to evaluate the effect of postoperative hair transplantation. The Global Aesthetic Improvement Scale (GAIS) and patients' objective satisfaction were used as evaluation indexes and determined by surgeons and patients.

We randomly selected three parts of the child's affected area to calculate the hair survival rate. The hair survival rate is equal to the number of FU/cm² at the last follow-up examination/the number of FU/cm² immediately after surgery × 100%.

SPSS 22.0 statistical software was used to analyze the data, and the counting data were represented as an example (%); the measurement data that conformed to normal distribution were expressed as mean ± standard deviation.

RESULTS

Thirteen children were included in this study, including ten males and three females, aged from 4 years 1 month to 12 years 10 months, with an average age of 7 years 5 months. Two hundred to 2500 hair follicle units were extracted, with an average recipient area of 22.7 cm², an average hair follicle unit density of 55.3 ± 9.1 per cm², and an average hair/FU ratio of 1.75 ± 0.07. Thirteen children in this group were followed up for 6–12 months with the following treatment options: FUE (9 cases), FUT (3 cases), and FUT combined with FUE (1 case). The average hair survival rate was 85.3%. Except for one child with temporary folliculitis, no complications were observed. No obvious scar or abnormal hair was noted in the incision of the donor area. The GAIS scoring was divided into five levels: complete improvement (2 cases), obvious improvement (10 cases), partial improvement (1 case), no improvement (0 cases), and deterioration (0 cases). The patient satisfaction results included very satisfied (2 cases), mostly satisfied (10 cases), and dissatisfied (1 case).

TYPICAL CASES

Case 1: A 7-year-old boy with a scalp hair defect of approximately 35 cm²; 2500 hair follicle units were transplanted using FUE in the posterior occipital donor area. After 1 year of follow-up, the hair survival rate was 85.7%. The hair growth in the hair transplant area of the patient was natural, and the patient and their family were satisfied (Fig. 1).



Fig. 1 Typical images of a child with autologous hair transplantation

DISCUSSION

Scarred hair defects in children are most common after scalp burns, trauma, and head surgery. Children with cicatricial baldness on the scalp are mainly treated by skin flap transfer, scar reduction surgery, tissue expansion surgery, silicone rubber wire traction-assisted scalp extension surgery, and hair transplantation [1, 2]. Before hair transplantation, it is necessary to evaluate the tissue thickness and composition of the scalp scar tissue as well as the scar area [3], which can assist in ultrasound and x-ray examination.

Small or finely designed scar baldness is the main indication for hair transplantation. When it is difficult to estimate the number of hair follicle units transplanted in a scar area, holes can be prepared before the recipient area, and the corresponding number of hair follicle units can be obtained from the donor area based on the number of holes. Usually, scars are treated after entering a stable stage. If the subcutaneous tissue is thin and even the skin adheres to the bone, hair transplantation should be performed after skin flap transfer or fat transplantation [4, 5].

At present, hair transplantation technology is widely used in adult hormone-related alopecia and cicatricial alopecia, but there are

currently few reports on cicatricial alopecia in children [6–8]. Children's hair transplantation has problems such as long surgical time, high risk of bleeding, and poor compliance by young children. Under local anesthesia, hair transplantation is significantly limited, and it often requires specialized hospitals with extensive experience in pediatric general anesthesia to carry out general anesthesia surgery. The age range of the study subjects was 4–12 years old, all undergoing general anesthesia surgery. Factors that need to be noted before and after surgery include: (1) children whose appearance has been seriously affected can undergo surgery before school age to reduce their inferiority complexes; (2) for large-scale hair transplants with a size > 1500 units, it is necessary to plan the surgical time and perform hair transplants in installments; (3) after surgery, 2% minoxidil can be used externally to assist in hair growth [9]. The appropriate surgical method should be chosen according to the specific situation. The FUE method is more minimally invasive and suitable for stable cicatricial alopecia in the anterior hairline and in temporal and parietal regions of the scalp, especially for scattered scars after burns. Research has found that, due to the close distance between the scar recipient area and the donor area, the inflammatory response during the postoperative wound healing process

is not conducive to the survival and regeneration of hair [10–12]. Therefore, hair transplantation should be avoided in acute wounds or scalp areas with inflammation. However, the leftover dog ear tissue from surgery can be fully utilized, as it contains many hair follicles that can be used for hair transplantation.

As a free tissue, any prolonged drying, trauma, or ischemia of the hair follicle unit will reduce its survival rate [13]. Compared to the collection of hair follicles from ordinary hair transplant donor areas, scar baldness areas have a hard texture, poor blood supply, and high surgical difficulty. The corresponding hair follicles have a longer preservation time in vitro, so the activity of hair follicles is more easily affected [14]. The recommended density for adult scalp grafts is 30–40 plants/cm², while for children with abundant scalp blood supply, the transplant density can be appropriately increased. The average density of scalp hair transplant patients in this group is 55.3 strains/cm² (survival rate is 85.3%), and the clinical effect is satisfactory. Previous research reported that PRP (platelet-rich plasma) can release many cytokines, improve the texture of scars, promote local angiogenesis of hair follicles, improve ischemic status, and accelerate the transition from resting to growing hair follicles [15]. Therefore, we can explore whether PRP combined with various autologous hair transplantation techniques can further improve postoperative efficacy.

The hair/FU ratio refers to the ratio of a certain number of hair follicle units to the total number of hairs [16]. We observed that the larger the hair/FU ratio of the patient's donor area was, the higher the proportion of hair follicle units containing two or more hair follicles. Therefore, it is easier to achieve a large hair volume during FUE. Professor Wang Jiping generally divides the average root to root ratio of patient donor hair into four levels: Good, the average root to root ratio ≥ 1.8 . Generally, ≤ 1.5 is the average root to root ratio < 1.8 . Poor, ≤ 1.2 . the average root to root ratio < 1.5 . Very poor, the average root to root ratio < 1.2 . The average root to root ratio of hair in the donor area < 1.5 is poor. Very poor, the average root to root ratio of hair in the donor area is $<$

1.2. The average hair/FU ratio of all patients who used FUE technology alone in this study is 1.77 ± 0.08 , which is more time- and labor-saving.

In addition, during the surgery process, due to maintaining a prolonged prone position during the top occipital hair transplant, it is necessary to pay attention to protecting the facial skin to prevent pressure injuries. Children's blood volume is smaller than that of adults. To minimize bleeding in the surgical area and alleviate postoperative pain, pre-prepared lidocaine combined with adrenaline swelling solution can be injected into the preferred hair area. Children's scalp is soft, and additional physiologic saline can be injected into the skin and subcutaneous superficial fascia layer to fully swell and maintain tension, facilitating the extraction of hair follicles.

Some possible limitations are as follows: (1) The longest follow-up time in this study was 12 months, and cases with > 12 -month follow-up are required. (2) Hair transplant surgery is less common in children, so we need to further expand the sample size.

CONCLUSION

The technique of autologous hair transplantation is minimally invasive, especially suitable for children with cicatricial alopecia, and is a safe and reliable treatment method.

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Author Contributions. The authors' contributions were as follows. YW contributed to the conception and design of the study. JW, JL contributed to acquisition, analysis and

interpretation of the data. JW, JL wrote the MS. JC, YW revised the MS. All authors read and approved the final manuscript.

Ethics Statement. This study conforms to the basic principles of the Helsinki Declaration and has been reviewed by the Ethics Committee of Beijing Children's Hospital Affiliated to Capital Medical University (Ethics Review Number: 2022-E-143-R). Patients signed informed consent regarding publishing their data and photographs.

Data Availability. The original data presented in the study are included in the article material; further inquiries can be directed to the corresponding authors.

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