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CASE REPORT

Hair Transplantation on Free Flap in a Patient with Malignant Scalp Neoplasms: A Case Report

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Abstract: This case report describes a pioneering approach to address severe alopecia following free flap reconstruction for malignant scalp tumor resection. A 41-year-old female with recurrent malignant fibrous histiocytoma underwent extensive scalp resection (10 cm × 21 cm defect) repaired with a free anterolateral thigh flap. While the flap healed successfully, the resulting baldness caused significant psychological distress, leading her to decline conventional scalp expansion due to its invasiveness. Instead, we performed staged autologous hair transplantation directly onto the flap—a technically challenging endeavor given the flap's thin skin, thick subcutaneous fat, and compromised vascularity. Using follicular unit extraction (FUE), the first session (2,289 grafts) followed partial flap resection, and the second session (2,571 grafts) was conducted 18 months later. Key adaptations included low-density implantation (30–40 FU/cm²), controlled graft depth, and tumescent solution to maintain skin tension. Follow-up revealed encouraging graft survival (~60% initially, rising to ~70% in the second session), achieving complete coverage at ~35 FU/cm² with no complications. The patient expressed high satisfaction with the natural aesthetic outcome. To our knowledge, this represents the first such case reported in China and only the third globally, demonstrating that staged FUE transplantation on free flaps is a viable, minimally invasive solution for post-oncologic alopecia when traditional methods are contraindicated or refused. This technique expands reconstructive options for patients prioritizing both cure and quality of life.

Keywords: malignant scalp neoplasms, free flap transplantation, follicular unit extraction, hair transplantation, alopecia management, staged surgery

Introduction

Large-scale scalp defects resulting from malignant tumor resection pose significant reconstructive challenges. Free flap transplantation, particularly with the ALT flap, has emerged as an effective method for restoring tissue integrity. However, secondary alopecia following flap reconstruction remains a critical issue, often leading to psychological distress. Traditional treatments like scalp expansion are frequently declined due to their invasiveness, highlighting the need for minimally invasive hair restoration strategies.

Scalp reconstruction options vary based on defect size: small wounds may be repaired with local flaps or skin grafts, while large defects (typically >10 cm in diameter) require vascularized free flaps. The ALT flap is preferred for its reliable blood supply (descending branch of the lateral circumflex femoral artery), moderate thickness, and minimal donor site morbidity. Compared to flaps like latissimus dorsi (LD) or gracilis, the ALT flap causes less motor function impairment and allows tension-free anastomosis to superficial temporal vessels.

Hair transplantation on free flaps is technically challenging due to the flap's thin skin, thick subcutaneous fat, and compromised vascularity. Prior studies have reported limited cases: Levesque[1] described beard reconstruction on an iliac crest flap, and Veir[2] reported scalp hair restoration on an LD flap. This case expands the literature by demonstrating successful FUE on an ALT flap, a first for scalp reconstruction in China.

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Case Report

A 41-year-old female patient seeks treatment for "recurrent fibrous histiocytoma of the scalp after resection, with recurrence for 2 months". She has undergone three surgeries over the past four years.

First Surgical Procedure: Scalp Tumor Resection and Free Flap Wound Coverage. This patient was admitted to the Department of Neurosurgery at Shanghai Ninth People's Hospital due to a recurrent scalp fibrous histiocytoma, 2 months after initial excision. Following a joint consultation with neurosurgeons and plastic surgeons, a combined procedure was performed: extensive resection of the scalp tumor followed by coverage with a free anterolateral thigh flap. Preoperative tumor size was approximately 5 cm × 6 cm (Figure 1), with enhanced MRI indicating skull involvement but no lymph node metastasis. No metastatic lymph nodes were found on neck ultrasound. The preoperative design included an expanded scalp resection area of 9 cm × 20 cm, encompassing the scar from the previous surgery. The anterolateral thigh flap was designed based on high-frequency color Doppler ultrasound to identify the blood supply, course, surface location, and hemodynamic characteristics of the descending branch of the lateral circumflex femoral artery, resulting in an elliptical flap of approximately 10 cm × 22 cm (Figure 2). Intraoperatively, the tumor was resected, and the eroded skull, involving the outer table, was covered with a titanium mesh after extensive resection. Joint consultation with neurosurgeons confirmed safe resection margins, and titanium mesh implantation was performed to protect the underlying neurostructures. After intraoperative frozen section confirmed negative margins, the final defect measured approximately 10 cm × 21 cm (Figure 3). The flap was harvested using the "convergent method", a technique involving bilateral dissection toward the preoperatively Doppler-identified vascular pedicle, allowing tension-free primary closure of the thigh donor site due to the patient's skin laxity. The flap was then transferred to cover the wound, with anastomosis to the recipient vessels (superficial temporal artery and vein) (Figure 4). Postoperatively, Doppler monitoring confirmed complete flap survival, with no recurrence at 12-month follow-up, with the patient expressing satisfaction. The patient had no history of radiation therapy.

Second Surgical Procedure: Hair Transplantation. Due to the patient's high aesthetic demands, the large unshielded alopecia area caused distress in her life and induced feelings of inferiority and depression. She sought treatment at our hospital to address the hair loss issue. Given the large alopecia area, approximately 8 cm × 16 cm, a "scalp expansion surgery" was suggested, but the patient declined due to the extensive trauma and the need for a two-stage procedure.

Figure 1 Preoperative appearance of the scalp fibrous histiocytoma with a protuberant mass on the top of the head.

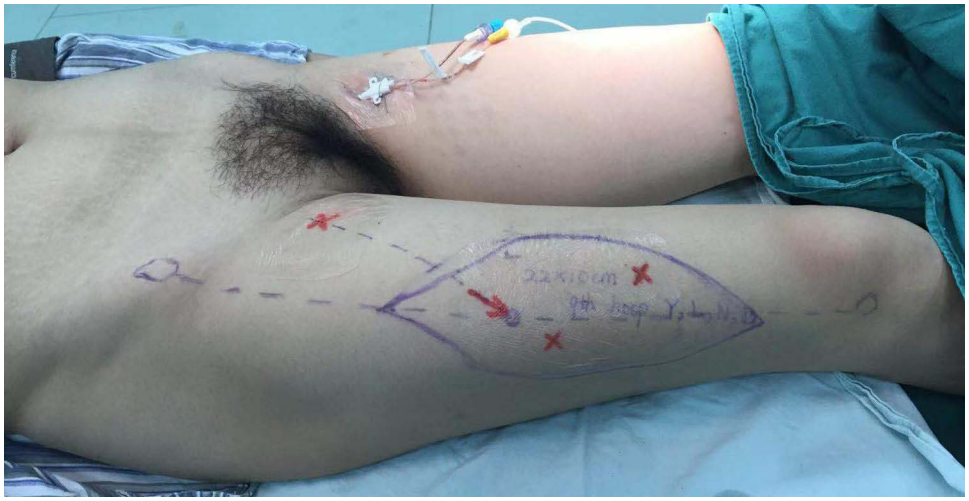

Figure 2 Preoperative planning of the donor site: anterolateral thigh flap.

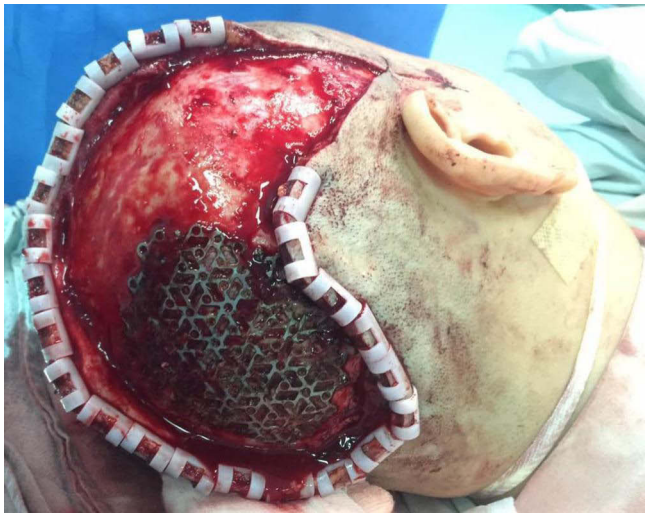

Figure 3 Intraoperative view of the extensive resection of the scalp lesion.

Autologous hair transplantation was then recommended. After assessing the flap's blood supply and the quality of the donor area hair, the patient was informed that the thin skin, thick subcutaneous fat, and poor blood supply of the free flap might necessitate two hair transplantation sessions for satisfactory results. Following thorough communication and weighing the pros and cons, autologous hair transplantation was chosen to cover the alopecia area. Due to the high elasticity of the patient's occipital scalp and the presence of a free flap crossing, FUT was not feasible, and follicular unit extraction (FUE) was selected to obtain follicular units. The first procedure involved partial flap resection to reduce alopecia area by 2 cm (Figure 5), followed by FUE of 2289 grafts (Figure 6). Local anesthesia with tumescent solution was used, and the surgery lasted 5 hours. FUE used punch diameter was 0.8–1.0 mm, the gem knife was used for punching followed by implantation with implantation density at 30–40 FU/cm² to avoid vascular compromise. At 12-month follow-up, graft survival was ~60%, with no complications such as folliculitis or subcutaneous cysts (Figure 7). The number of surviving hairs per square centimeter is counted one by one under the trichoscope.

Third Surgical Procedure: Additional Hair Transplantation for Density. One year postoperatively, the patient felt the hair density in the alopecia area was low, and the hair did not fully cover the scalp. Eighteen months later, the patient requested increased density. A second FUE session transplanted 2,571 grafts over 6 hours under local anesthesia (Figure 8). One-year follow-up showed ~70% survival, achieving complete coverage at ~35 FU/cm². The patient reported

Figure 4 Intraoperative application of the anterolateral thigh flap for wound coverage.

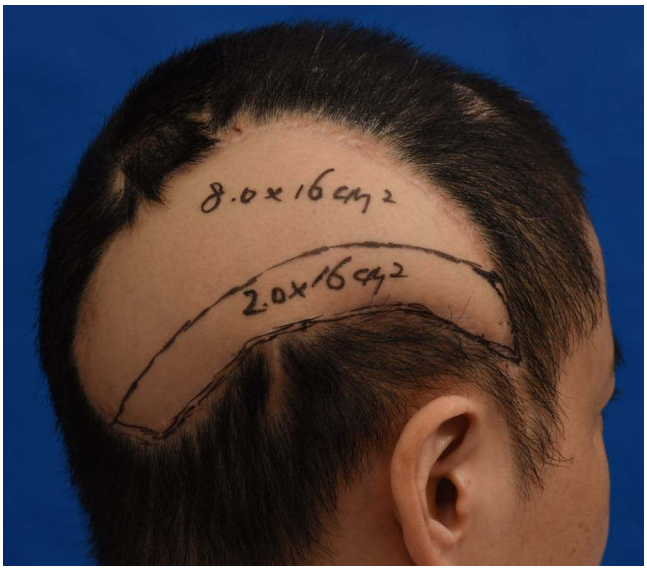

Figure 5 Preoperative for hair transplantation: the anterolateral thigh flap has healed well, with plans for partial flap resection combined with FUE (Follicular Unit Extraction) hair transplantation.

high satisfaction with the natural appearance (Figure 9). The patient did not receive postoperative medical hair loss therapy.

Discussion

Common scalp malignancies mainly include squamous cell carcinoma and fibrous histiocytoma. Extensive resection is one of the standard surgical treatments. Often, patients with scalp malignancies have a long course, seek medical attention late, or have had multiple tumor resections at other hospitals, leading to large tumor invasion areas. The wound after extensive resection is typically circular or elliptical, with the short diameter greater than 10 cm and the long diameter greater than 15 cm. The challenge in the surgical treatment of large scalp tumors lies in the reconstruction of tissue defects after resection. Due to the toughness of adult scalp skin, small wounds can be repaired by forced

Figure 6 Immediate postoperative view after partial flap resection combined with FUE hair transplantation, with a total of 2289 follicular units transplanted.

Figure 7 One-year follow-up after the first hair transplantation surgery, showing hair coverage over the surgical site, but with a relatively sparse hair density.

approximation and local scalp flaps, but large scalp wounds are difficult to repair with surrounding tissues.[3] Moreover, during extensive tumor resection, the periosteum is often removed together, exposing the skull, making it impossible to cover the wound with a skin graft in one stage. The use of a free flap to reconstruct large defects after the resection of scalp malignancies is an ideal method.

Currently reported flaps include latissimus dorsi myocutaneous flaps, anterolateral thigh flaps,[4] gracilis muscle flaps, and deep inferior epigastric artery perforator flaps, etc. Some scholars believe that compared to anterolateral thigh

Figure 8 Immediate postoperative view following the second session of FUE (Follicular Unit Extraction) hair transplantation, with a total of 2571 follicular units transplanted.

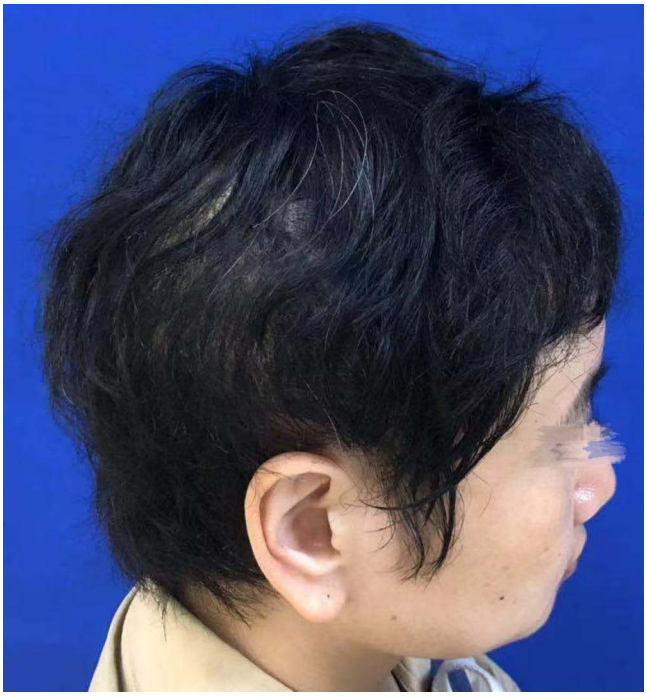

Figure 9 One-year follow-up after the second hair transplantation surgery, demonstrating complete hair coverage over the alopecia area with patient satisfaction.

perforator flaps, the impact on the patient's motor function after harvesting the gracilis and latissimus dorsi muscle flaps is relatively greater;[5] the deep inferior epigastric artery perforator flap has only one donor area in the human body and should be used sparingly, starting with flaps that have multiple alternative donor areas. The descending branch of the

anterolateral thigh perforator flap can reach about 17 cm, and the oblique and transverse branch vessels can reach about 10 cm, allowing for tension-free anastomosis to the superficial temporal vessels or facial artery and vein. The anterolateral thigh perforator flap has a moderate thickness and can be thinned in obese patients, without causing local swelling when transferred to the scalp, resulting in a satisfactory appearance. In addition, the flap has a reliable arterial blood supply, and the venous blood mainly returns through the perforator vessel pedicle, without the need for additional anastomosis of the superficial veins of the skin, reducing the incidence of complications.

Secondary alopecia after free flap wound repair is also a significant concern for patients. The most common secondary alopecia in burn plastic surgery is cicatricial alopecia. Cicatricial alopecia refers to permanent hair loss accompanied by irreversible damage to the hair follicles, with a large number of collagen fibers proliferating to form scars in the hair follicle area.[6] Although the causes of secondary alopecia after free flap wound repair and cicatricial alopecia are different, the symptoms are the same, and the treatment methods are also the same, mainly surgical, including traditional surgical methods such as scalp reduction and flap repair, and common surgical methods such as skin and soft tissue expansion and hair transplantation.[7,8] Although skin and soft tissue expansion surgery was once the gold standard for the treatment of large area secondary alopecia, for scalp malignancy patients, due to the previous huge surgical trauma, patients often refuse to undergo long-term, high-trauma surgery again, making hair transplantation the best choice. Hair transplantation is more convenient and has a shorter treatment cycle than flap transfer and skin and soft tissue expansion surgery, and can be transplanted according to the characteristics of the surrounding hair of the bald area, overcoming the shortcomings of inconsistent hair angle, direction, and density after flap repair, achieving better aesthetic effects, and also has the advantages of short recovery period and few complications.[9]

Hair transplantation is a surgical method of obtaining hair follicles from the occipital scalp and implanting them into the bald area. The development of hair transplantation has gone through two centuries. In 1959, N Orentreich et.al[10] proposed the "hair transplantation donor area advantage theory", laying the theoretical foundation for modern hair transplantation. Hair transplants have also gone through changes from large grafts (regional skin flaps, ring drill rough materials) to small and mini grafts. In 1894, JT Headington et.al[11] proposed the concept of hair follicle units, opening a new era for hair follicle unit transplantation. With the continuous development of hair transplantation technology, a theoretical system with follicular unit scalp strip transplantation (follicular unit transplantation, FUT) and follicular unit extraction (follicular unit extraction, FUE) as the mainstream methods has been formed. FUT involves cutting a scalp strip from the occipital donor area, separating the scalp strip into individual hair follicle unit transplants under a microscope or magnifying glass, and then transplanting them to the recipient area. FUE uses a circular knife to cut around the individual hair follicle unit in the donor area, cutting the connection between the hair follicle unit and the surrounding tissue in the middle layer of the dermis, and then completely taking out the hair follicle unit and transplanting it to the recipient area. Compared with the two technologies, FUT is simpler and easier to master, but the workload of separating hair follicle units after cutting is larger, and the time consumption is longer, which needs to be completed by a skilled team. FUE has the advantages of less trauma and faster recovery. FUT was once the gold standard for hair transplantation technology. In 2004, among the hair transplantation surgeries of ISHRS physician members, FUT accounted for 93%, and FUE only accounted for 6%; with the development and improvement of FUE and equipment, the proportion of FUE has been increasing year by year. By 2014, the two technologies each accounted for half; and by 2019, FUE had become the most commonly used technology with a proportion of 66%, FUT accounted for about 30%, and the combined surgery of FUE and FUT accounted for about 4.20%.[12] And in China, this phenomenon is more prominent. In recent years, except for a few large public hospitals, few institutions use FUT.

The uneven thickness of scars, different textures, and poor blood circulation conditions make autologous hair transplantation on scars itself challenging, with generally lower survival rates, and may require multiple surgeries to achieve satisfactory hair density. Although the texture of the free flap is different from that of the scar, the thin skin, thick subcutaneous fat, and poor blood circulation also require multiple hair transplantation surgeries to thicken and achieve satisfactory results. The feeling of hair transplantation on the free flap is similar to that of pubic hair transplantation in the pubic area, and the flap skin is similar to the perineal skin, which is more relaxed and soft, so it is necessary to inject enough swelling fluid in the recipient area to maintain moderate skin tension, facilitating punching and implantation.[13] The punching method can choose to punch with a gem knife first and then implant, or choose to punch and implant with

a micro-needle at the same time, and the punching should not be too deep or too shallow, because the flap skin is thin, if implanted too deep, local depression will affect the appearance, and too shallow will easily cause the "jump embryo" phenomenon. Free flap recipients differ from native scalp in tissue texture and vascularity. The ALT flap's thin skin and thick subcutaneous fat necessitate careful graft depth control to avoid depression or "pop-out". Low-density implantation (30–40 FU/cm²) is critical to prevent ischemic injury. This is supported by prior cases: Han et al[14] reported 80–85% survival on an LD flap with 1,500 grafts, while Sokoya et al[15] noted "reasonable" survival on radial forearm flaps.

To date, limited cases have explored hair transplantation on free flaps. Notable examples include beard reconstruction on an iliac crest flap (Levesque, 2011),[1] scalp hair restoration on an LD flap (Zoran V, 2017),[2] radial forearm flap applications (Sokoya, 2018),[15] and an LD flap case with 80–85% graft survival (Han, 2024).[14] Our report is the first on an ALT flap for scalp reconstruction. Emerging technologies like the ARTIA system may optimize follicular extraction, though their role in compromised vascular beds (eg, free flaps) remains unproven.

In this study we report a case of patient with a protruding fibrosarcoma of the scalp, after consultation with neurosurgeons and plastic surgeons, a combined surgery was performed - expanded resection of the protruding fibrosarcoma of the scalp+free anterolateral thigh flap covering the wound. After surgery, all flaps survived and had good blood circulation. The patient sought treatment again for secondary alopecia after repairing the wound with a skin flap. In order to achieve better hair coverage with smaller surgical trauma, we transplanted 4860 hair follicle units onto the anterolateral thigh skin flap in two installments. The hair follicle survival rate was high and patient is very satisfied. Therefore, hair transplantation is a feasible, simple, and aesthetically pleasing method for treating secondary alopecia after extensive scalp defects.

Conclusion

For patients with scalp malignancies, it is necessary to not only extend the survival rate by extensive resection but also meet the aesthetic needs of covering the bald area. The combination of free flaps and multiple autologous hair transplantations is a good choice, especially the hair transplantation surgery has multiple advantages such as small trauma, fast recovery, and good effect, which is worth promoting in clinical practice.

Ethics and Consent Statement

The written informed consent was obtained from the patient for the publication of the case details and images. No further institutional approval was required.

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Disclosure

The authors report no conflicts of interest in this work.

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