Total Scalp Replantation: Surgical Tricks and Pitfalls

Serdar Nasir, MD, Mehmet Karaaltin, MD,† and Adnan Erdem, MD‡*

Background: Two patients were successfully operated on for total scalp avulsions.

Methods: Ages were between 11and 35 years, and both patients were female. Bilateral temporal artery and veins were used as the recipient pedicles. Interpositional vein graft harvested from the left forearm was used in 1 patient. No nerve repair was performed.

Results: The scalp was successfully replanted in both cases. Venous congestion and arterial insufficiency were observed in 1 patient. Successful revision of the vascular anastomosis was performed. Total necrosis of the upper helical rim was observed in 1 patient. A mean size of 3 × 3 cm of tissue necrosis was observed in the occipital region of all patients. One patient was treated with split-thickness skin grafting, whereas the other one was left for secondary healing.

Conclusions: The "replace like tissue with like tissue" represents the philosophy in replantation surgery. Although reconstructive surgeries imply advanced surgical methods, scalp replantation remains the only ideal surgical modality to create an embellishing natural-looking hair-bearing scalp. In this article, we present some tricks and pitfalls of total avulsed scalp replantation as well as our skills and literature review.

Key Words: Scalp replantation, microsurgery, scalp reconstruction

(*J Craniofac Surg* 2015;26: 1192–1195)

The scalp is a unique body structure that consists of densely packed hair follicles, a thick subcutaneous layer, and a neurovascular bundles. The scalp has both practical and cosmetic importance, as it retains body warmth and complements personal and social status, respectively. Although total scalp avulsion is rather an unusual injury in daily clinical practice, its treatment is very intractable. Replantation remains the only efficacious surgical method to achieve hear-bearing aesthetic unit. If the replantation attempt fails, additional operations are required, including skin grafts and/or free tissue transfer. However, significant areas of alopecia are unavoidable, which prevents good aesthetic outcome.[1–4] Despite an appropriate coverage of hair-bearing scalp with these treatment methods, psychological repercussions of disfigurement persist.[5] Total scalp amputation was caused by severe shearing forces applied obliquely to the hair-bearing scalp, which generally occurs when long hair is caught in rotating devices, such as agricultural machines. The forehead, portions of the ear, whole ear, eyebrows, and upper nasal skin are also commonly involved in most avulsed scalp cases. Revascularization of amputated scalp may provide blood supplies of these tissues with random pattern. But skin attachment of the ear to the main part of the scalp is less; ear needs separate vessel anastomosis to nourish it. Furthermore, scalp replantation needs very special technical details during the operation and postoperative period. This article aims to present experience of both cases of replantation of total avulsion of the scalp and to describe our recommendations regarding the technical tips and pitfalls to make this rare procedure easier and successful.

PATIENTS AND METHODS

Between the years 2007 and 2009, we have successfully performed replantation in 2 patients who had total scalp avulsions. Despite the extensive scalp injury, all patients received initial evaluation and treatment at the emergency department for stabilization. All patients were examined for hemorrhagic shock and life-threatening injuries, such as pneumothorax, bone fractures, cervical spine dislocations, and intracranial injuries, which is the most important aspect especially when dealing with juvenile patients and thus should precede scalp replantation. All scalps were replanted by a single team. The first step involved shaving of the scalp hair. Many authors have expressed difficulty and cautioned leaving hair particles on the underside of the amputated scalp, which resembled 10-0 nylon sutures during the microanastomoses. We used simple shaving technique, which has been similarly described in the previous reports.[6] The inner surface of the avulsed scalp was filled with gauze pads, and thus the spherical scalp shape was provided to ease shaving and protect the inner surface from hair tufts. The gauze-stuffed scalp was primarily placed on a surgical spherical vessel. The long hairs were then clipped, and shaving from front to back and side while protecting the eyebrows was accomplished. After the shaving was completed, the scalp was washed with surgical scrub brush, and all hair tufts were removed completely (Figs. 1 and 2). The scalp was taken off the container, and gauze pads were removed. In this manner, the scalp was well prepared in the short term, and no hair remnants were found on the inner side.

All operations were performed on the basis of exploring the possible vessels in the amputee scalps prior to admitting the patients to the operative theater. In all cases, we have been able to identify at least 1 artery or/and vein in the temporal region on both sides of the scalp. The aponeurosis was incised and dissected

FIGURE 1. Scalp filled with the gauze to provide easy shaving and avoid hair contamination.

From the *Department of Plastic, Reconstructive and Aesthetic Surgery, Hacettepe University, Ankara; †Department of Plastic, Reconstructive and Aesthetic Surgery, Bezmi Alem Vakif University, Istanbul; and ‡Private Practice, Bursa, Turkey.

Received October 22, 2014.
Accepted for publication January 26, 2015.

Address correspondence and reprint requests to Serdar Nasir, MD, Department of Plastic, Reconstructive and Aesthetic Surgery, Hacettepe University, 06100 Sihhiye, Ankara, Turkey;
E-mail: snasir@hacettepe.edu.tr, snasir72@gmail.com

The authors report no conflicts of interest.

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000001646

FIGURE 2. Hair shaving of scalp on the surgical spherical vessel.

FIGURE 3. The 11-year-old boy sustained a scalp avulsion injury.

to isolate the vessels and prepare a 2- to 3-cm mobilized stump. For some authors, to differentiate artery from vein, portions of the vessels were sent for frozen section.[7] We believe that differentiating artery from vein is not difficult. The vein is differentiated from artery by wall thickness. Because of their tendency to dilate, they are capable of carrying considerable quantity of blood. Vessel identification was marked with 8-0 nylon suture at the subcutaneous tissue level near the prepared vessels. This step was very important, because placing the avulsed scalp on the head makes the identification of prepared vessels very difficult. The damaged segments of the vessels were cut off thoroughly until vital endothelial lining appeared under the microscope magnification. At this stage, the patient was anesthetized, and recipient vessels were prepared. Although it was reported that single artery and vein repair provide entire scalp perfusion,[7,8] we prefer a of minimum 2 arteries and 2 vein anastomoses. Vein grafts were preferred in circumstances that tension might have jeopardized the anastomosis in return. Anchoring the scalp to the periosteum with absorbable sutures applied close to vessel routes also provided a secure natural lock to prevent sharing forces that might have led to a kink or rupture of anastomozed vessels in return. These maneuvers provided extra security during head movement.

PATIENT 1

Long hair of an 11-year-old girl was caught in rotating devices of an agricultural machine. On admission to hospital, she was conscious

FIGURE 4. The avulsed scalp.

FIGURE 5. Immediate after replantation of amputated scalp.

and stable and had little bleeding. The avulsed scalp involved the entire hairy scalp, forehead, left helix of the ear, both eyelids, both eyebrows, and glabellum skin of the nose. Bilateral superficial temporal arteries and veins were prepared in the amputated scalp and recipient area. End-to-end vascular anastomoses were adopted between recipient vessels and amputated part. After finishing all anastomoses, the entire scalp became nourished and had bright red bleeding from the edges and undersurface and showed good dermal bleeding. Vacuum drainage tubes and 2 rubber tissues were inserted beneath the replanted scalp on both sides. The total operative time was 5 hours 30 minutes about 6 hours after the accident. On postoperative 6 hours, no blood flow in 3×5-cm area of the parietooccipital region was observed because of the severely injured dermal plexus. Two days after surgery, left helix of the ear showed cyanosis, and leeches were applied. Yet, this part was lost because of necrosis. Four days after surgery. A 3×3-cm pressure sore noted at the occipital area resulted from the constant supine position. Although 90% of the scalp was able to survive, the patient was brought back to the operating room within few weeks for a secondary debridement and split thickness skin graft coverage. The final aesthetic result was very satisfactory before expansion to remove alopecic area and cover with hairy skin. The overall result was satisfactory (Figs. 3–6).

PATIENT 2

A 35-year-old woman got her hair caught on a roller machine while at work, and entire scalp, including the frontal area including the eyebrows, was totally amputated. Left superficial temporal vessels and 3 occipital veins were prepared for anastomosis in the amputee part and recipient area. Nerve coaptation was not performed. Total ischemia time was 15 hours, and operative time was 10 hours. At the postoperative day 2, entire scalp showed cyanochroia. All occipital and superficial temporal veins were inspected observed under operation microscope. Vein graft was harvested from the patient's forearm arm. Then interposition vein grafts were used for reanastomosis between superficial temporal veins of amputated part and recipient area. Five days after operation, a 4×3-cm pressure sore

FIGURE 6. A and B, One-year follow-up after replantation (front and side views). She has normal hair growth and good cosmetic result.

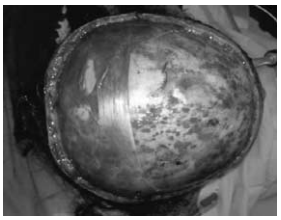

FIGURE 7. Vertex of scalp was amputated in the 35-year-old woman.

FIGURE 8. The amputated scalp covers nearly total hairy skin.

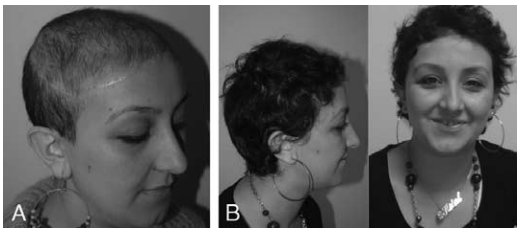

FIGURE 9. A and B, Very good aesthetic result at postoperative 1 year. The small alopecia area covered of hair and is not visible.

was noted at the occipital area, and the hairless area nevertheless was easily covered by hairstyling, so the patient did not request any further revisions. The patient was satisfied with the eventual outcome of the reconstruction (Figs. 7–9).

DISCUSSION

Classic boundaries of avulsed scalp may range usually from supratarsal fold or above of the brows to the lower occipital region and bilateral or unilateral superior portion of the helical rims in the temporal sides. The cause of this laceration line during scalp avulsion is due to the tight connections existing between the scalp and epicranium. Epicranium has no bony attachments, and it is directly blended with corrugator and orbicularis oculi muscles. Furthermore, this part of the scalp is indirectly connected with the bony skull. Scalp is amputated from this muscular level, which are the upper eyelids, or above the brows according to avulsion strength and traction vector. In posterior aspect, scalp is torn from the linea nuchea region of the occipital bone at which epicranium is bind with the cranium in this line. On the temporal-side region, epicranium gives origin to the auricularis and continued over the temporal fascia to the zygomatic arch. Similarly, the upper pole of the auricle is usually amputated with scalp during avulsion trauma because of this tight connection of bone and epicranium.[9] As suggested from previous reports,[6] restoring the blood supply of the amputated auricle was suggested that separate anastomosis of the auricular artery to provide upper pole circulation. We observed cyanosis in 1 case without separate arterial anastomosis, and it failed despite leech therapy. We speculated that this conflict or problem, this circulation disaster, was related to arterial circulation problem. Reduced arterial circulation may cause decreased capillary circulation, and it resulted in higher carboxyhemoglobulin and metabolic waste levels in this circulation disaster in blood. We think that leech therapy increased arterial blood supply failure in capillary network, and tissue necrosis was fastened. All the auricle parts of the other cases were viable because of the successful arterial anastomosis of the upper pole.

All cases had different sizes in a different extent of occipital skin necrosis. Similar findings were encountered in previous reports.[10] Actually, this finding was characteristically confined to the nuchal line of the occiput, which suggests that the tight junctions at the area may have created the resistance against the shearing avulsion forces and thus damage to the mentioned area. This necrotic part is usually circumference of linea nuchea of occipital bone. We suggested that tight connection between scalp and bone in this line may resist against traction force. This opposite vector may cause increased avulsion damage in this part of scalp skin. Another deteriorating effect on the area is the sustained supine position of patient. External pressure may sever capillary circulation. In this reported case series, despite all interventions regarding the prevention of pressure sores, necrosis was observed. So, according to our hypothesis, the shearing forces at the adherent occipital site actually have inflicted tissue damage instead; depending on conflict, force may be the main problem compared with pressure ulcer at occipital area.

Some surgical tricks and pitfalls are indeed important for a successful scalp replantation. They are directly affected by successful scalp replantation. When preparing the avulsed scalp, hair has to be shaved prior surgery, because tufts may spread underneath, which can bother the surgeon and cause difficulty under the microscope field. The authors advise a certain shaving technique, in which the scalp was filled out with surgical gauze and placed over a convex bowel to be shaved, avoiding contamination in return. Although previous reports stated that unilateral temporal artery and vein repairing can sufficiently nourish the entire scalp,[11] we suggested that bilateral repairing is more competent especially in adult patients who are vulnerable to thrombosis because of systemic vascular disease. This patient group has no good vessel connection between half of scalp due to arteriosclerosis or the same medical disorder. Most of the scalp amputations result from avulsion traumas that may lead to serious injury in the intimal wall of the habitant vessels, thus favoring thrombogenesis.[12] For this reason, the authors recommend a careful inspection of the vascular stumps and not to hesitate to resect the damaged vascular segment and use of interpositional vein grafts in return. In addition, the potential donor sites for vein graft harvesting should be prepared in advance. The other key point during surgery is the definite scalp immobilization achieved with the anchor sutures because relying on the edges sutures may jeopardize the vascular anastomosis when moving the head during surgery. Another pitfall is placing the anchor sutures as close as possible to the anastomosis site to further avoid the possible injury to it.

During the follow-up period, certain areas of tissue necrosis may be established. Such problem can be solved by immediate grafting or provide conventional wound care that promotes secondary healing. Afterward, the alopecic areas can either be camouflage by hairstyling or may be removed and covered with pre-expanded rotational flaps from the hair-bearing areas.

In summary, the general rule to replace ''like tissue with like tissue'' represents the philosophy in replantation surgery. Although reconstructive surgery has advanced surgical techniques and many alternative methods, only replantation of the amputated scalp will always maintain hair-bearing scalp compared with using free flaps, local flaps, or skin graft. As conclusion, all possibilities and efforts must be forced to replantation of amputated scalps.

REFERENCES

1. Araki K, Hatano T, Toki M, et al. Replantation of a totally avulsed scalp without microvascular anastomosis. *Acta Neurochir (Wien)* 1999;141:1353–1354
2. Terzioglu A, Aslan G, Saydam M. Trephination in the treatment of scalp avulsion: successful application of a historical method. *J Oral Maxillofac Surg* 1999;57:204–206
3. Pitkanen JM, Al-Qattan MM, Russel NA. Immediate coverage of exposed, denuded cranial bone with split-thickness skin grafts. *Ann Plast Surg* 2000;45:118–121
4. Furlanetti LL, de Oliveira RS, Santos MV, et al. Multiple cranial burr holes as an alternative treatment for total scalp avulsion. *Childs Nerv Syst* 2010;26:745–749
5. Mowlavi A, Bass MJ, Khurshid KA, et al. Psychological sequelae of failed scalp replantation. *Plast Reconstr Surg* 2004;113:1573–1579
6. Sabapathy SR, Venkatramani H, Bharathi RR, et al. Technical considerations in replantation of total scalp avulsions. *J Plast Reconstr Aesthet Surg* 2006;59:2–10
7. Wilhelmi BJ, Kang RH, Movassaghi K, et al. First successful replantation of face and scalp with single-artery repair: model for face and scalp transplantation. *Ann Plast Surg* 2003;50: 535–540
8. Nahai F, Hurteau J, Vasconez LO. Replantation of an entire scalp and ear by microvascular anastomoses of only 1 artery and 1 vein. *Br J Plast Surg* 1978;31:339–342
9. Furlanetti LL, de Oliveira RS, Santos MV, et al. Multiple cranial burr holes as an alternative treatment for total scalp avulsion. *Childs Nerv Syst* 2010;26:745–749
10. Yin JW, Matsuo JM, Hsieh CH, et al. Replantation of total avulsed scalp with microsurgery: experience of eight cases and literature review. *J Trauma* 2008;64:796–802
11. Eren S, Hess J, Larkin GC. Total scalp replantation based on one artery and one vein. *Microsurgery* 1993;14:266–271
12. Liu T, Dong J, Wang J, et al. Microsurgical replantation for child total scalp avulsion. *J Craniofac Surg* 2009;20:81–84

