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CASE REPORT
Reconstructive

Microsurgical Scalp Replantation: Lessons Learned and Technical Considerations

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Summary: Total scalp avulsion is defined as a severe soft-tissue injury which involves the hairy scalp and commonly occurs in women as a result of the entrapment of long hair in high-speed rotating industrial machinery. The first microvascular replantation of an avulsed scalp was described by Miller et al in 1976 when both superficial temporal arteries along with five veins were successfully reanastomosed. Our patient was managed with a vein graft measuring 8 cm in length for reanastomosis of the superficial temporal artery. Furthermore, after successful replantation, we used an expander for aesthetic refinement and achieved an excellent outcome. A scalp replantation should be performed in every possible case. Despite partial skin necrosis, hair growth in the remaining areas is possible. In cases of partial skin necrosis, it is possible to eliminate the hairless areas by implanting an expander and excising the hairless area. A pressure-related ulcer at the occiput is likely due to immobility of the head postoperatively and may be avoided by using a halo fixation device. *(Plast Reconstr Surg Glob Open 2022;10:e4155; doi: 10.1097/GOX.0000000000004155; Published online 30 March 2022.)*

Total scalp avulsion is defined as a severe soft-tissue injury which involves the hairy scalp and commonly occurs in women as a result of the entrapment of long hair in high-speed rotating industrial machinery.[1–4] The first cases described were managed by simply replacing the avulsed scalp as a free graft and suturing it in place.[5–7] However, this technique showed, with the exception of one case with a partially avulsed scalp described by Lu,[6] very poor results.[7] The first microvascular replantation of an avulsed scalp was described by Miller et al[8] when both superficial temporal arteries along with five veins were successfully reanastomosed.[7] Reports by Nguyen[9] and Nahai et al showed that scalp replantation is also possible with just one arterial anastomosis along with at least one vein anastomosis to achieve excellent aesthetic results.

Our patient was managed with a vein graft measuring 8 cm in length for reanastomosis of the superficial temporal artery. Furthermore, after successful replantation, we used an expander for aesthetic refinement and achieved an excellent outcome. The aim of our report is to propose a therapeutic-algorithm for this rare injury to facilitate further scalp replantation procedures and to provide evidence for future surgeons (Fig. 1).

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CASE REPORT

A 21-year-old woman lost her entire scalp due to her hair getting pulled into a rotating industrial machine (Fig. 2). Additional vital injuries, such as intracranial hemorrhage or spine injury, were primarily ruled out by computed tomography. The amputation flap was in good condition macroscopically and microsurgical scalp replantation was performed.

Cold ischemia time was approximately 2 hours and warm ischemia time approximately 3–4 hours. The procedure started with shaving of the scalp with a manual sterile shaver. Special attention should be given to small particles on the underside of the amputate that may be misinterpreted as suture material during the microsurgical procedure.

The next step was to explore the donor and recipient vessels for reanastomosis. One artery (superficial temporal artery) and two veins were reanastomosed. Differentiation of the artery and veins might be a problem during this procedure. For anastomosis of the temporal superficial artery, the right dorsalis pedis vein with a length of approximately 8 cm was used.

We were surprised by the extreme inflow and outflow from the flap. After satisfactory arterial reconstruction, we performed two venous anastomoses using the Coupler system. The next essential step was to achieve precise hemostasis using bipolar cautery due to the excellent perfusion of the replantated scalp. Furthermore, two suction drains

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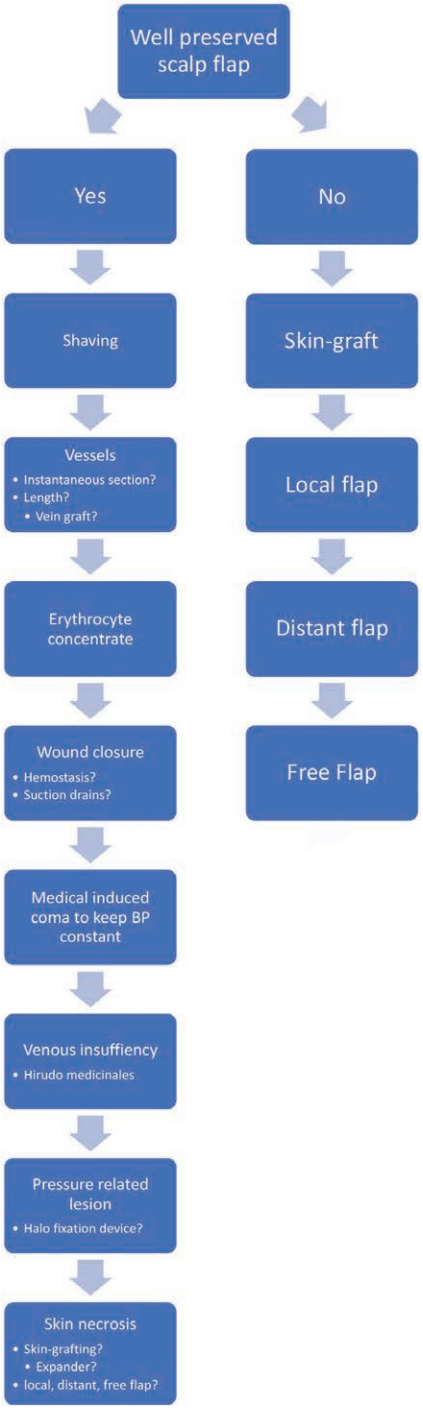

Fig. 1. Clinical algorithm showing possible pitfalls and options for the treatment of a patient after traumatic scalp avulsion.

were placed before wound closure using nonabsorbable interrupted single sutures.

A medically induced coma should be considered for at least the first 48 hours after surgery. We experienced excellent hemostasis, blood pressure control, and controlled flap perfusion using this procedure. Leeches (*Hirudo medicinalis*) for partial venous insufficiency were applied on day 2 as a supportive treatment.

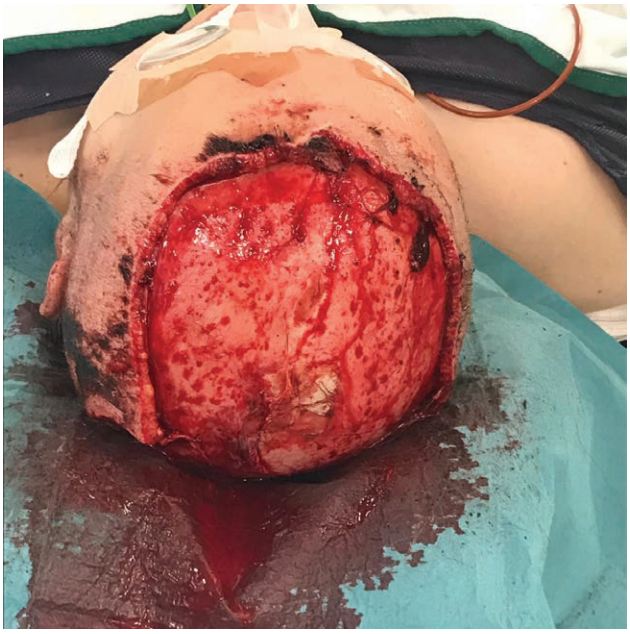

Fig. 2. The patient after scalp avulsion.

The patient woke up from coma on day 5. Although the scalp showed good circulation, a pressure-related lesion leading to skin necrosis developed on the occiput.

On day 21, the demarked area was excited and covered with a split-thickness skin graft. Lanugo hair growth was observed on day 21 (Fig. 3). However, some areas, especially the right parietal region, showed little hair growth. The reason for the reduced hair growth at this particular location was presumed to be mild latent ischemia (standard perfusion monitoring exhibited excellent results), because the arterial anastomosis was located on exactly the opposite side of the flap.

Fig. 3. Hairless area at the occiput after split-thickness skin grafting.

Fig. 4. The patient's occiput 2 weeks after explantation of the expander.

To cover the hairless area at the occiput, an expander was implanted 8 months after the accident. Simultaneously, platelet-rich plasma was injected in the areas with poor hair growth for stimulation of hair growth. The expander was filled over 12 weeks to over 350 mL.

Eleven months after the injury, explantation of the expander and excision of the skin-grafted area at the occiput was performed. Finally, an excellent overall aesthetic result was achieved after the procedure (Fig. 4).

DISCUSSION

In comparison with the first described scalp replantation by Miller et al, the biggest difference in our case was the number of anastomoses performed due to a more extensive injury.[6] Miller et al performed 13 microvascular anastomoses using multiple vein grafts. In our case, three vessels were reconstructed, including one vein graft for arterial reanastomosis. In both cases, excellent aesthetic and functional outcomes could be achieved.

The occipital and superficial temporal arteries are both an option. There may be a better network of collateral arteries accompanying one of these options, which may lead to better perfusion. A literature review revealed that there is currently no specifically designed anatomical study on this issue.

However, there is a relatively large number of studies regarding vessel anastomosis management. Nahai et al showed that reanastomosis of one artery and one vein can provide adequate perfusion, whereas Cheng et al described a better outcome when additional arteries and veins were used.[10,11] Overall, there is a consensus among multiple authors that as many vessels as possible should be reanastomosed to provide a satisfactory outcome.[7] Generally, we agree that as many vessels as possible should be reconstructed. What we want to emphasize on the basis of our experience is that one high inflow and outflow vessel is enough to cover the entire perfusion of the scalp flap due to an extensive plexus of collaterals.

Skin necrosis at the occiput after scalp replantation has been described several times in the literature. As mentioned before, malperfusion may be a reason. Additionally, the immobility of the head during the prolonged period of coma after the trauma has also been discussed. Furthermore, Nasir et al[12] claimed that the occiput experienced a greater force during the trauma, which could lead to greater vessel damage in that specific area. In a recent study, a halo fixation device was used as a possible solution to reduce pressure-related scalp injury.[1] This invasive procedure could significantly reduce the appearance of necrotic skin ulcers during scalp replantation. In our experience, skin necrosis was definitely not a result of malperfusion. The area concerned had a high predisposition to pressure sore-related ulcers due to postoperative immobility during the medically induced coma.

Although perfusion was excellent in our case, the right parietal region showed little hair growth. Hair follicles may be more vulnerable to ischemia and inflammatory mediators than other cell types. However, there is currently no study that investigates this question. Moreover, reanastomosis of a second closer artery may be beneficial.

In our case the alopecia at the occiput was treated with an expander. Instead of two sessions when using an expander, a V-Y-C or V-Y-S plasty could be considered for reconstruction of alopecia in one session.[13]

CONCLUSIONS

In this case, microsurgical scalp replantation with reanastomosis of one artery with a vein graft, along with reanastomosis of two veins ensured adequate circulation. A scalp replantation should be performed in every possible case. Despite partial skin necrosis, hair growth in the remaining areas is possible. In cases of partial skin necrosis, it is possible to eliminate the hairless areas by implanting an expander and excising the hairless area. A pressure-related ulcer at the occiput is likely due to immobility of the head postoperatively and may be avoided by using a halo fixation device.

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