

Revolutionizing Scalp Avulsion Treatment: Unleashing the Therapeutic Potential of Pentoxifylline: A Case Report

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Abstract: Scalp avulsion injuries presents a challenging with life threatening clinical scenario, often requiring immediate surgical intervention to optimize patient outcomes. we present a case of scalp avulsion injuries managed surgically using primary closure with meticulous debridement and re - approximation of the avulsed scalp tissue followed by layered closure of the underlying structures and combination with therapeutic administration of pentoxifylline. The patient received pentoxifylline as a therapeutic adjunct to promote wound healing and mitigate the risk of ischemia - related complications. The use of pentoxifylline was guided by its potential to improve microcirculation and tissue oxygenation, thereby supporting the healing process in avulsed scalp injuries. The use of pentoxifylline was associated with enhanced tissue perfusion and reduced edema, contributing to the overall success of the management strategy. The outcomes of this combined approach were assessed in terms of wound healing, complications, and cosmetic results. The result demonstrated that the surgical management utilizing primary closure, supplemented by the therapeutic administration of pentoxifylline, yielded favourable outcomes. The combination approach facilitated successful wound healing, reduced the incidence of ischemia - related complications, and contributed to improved cosmetic results.

Keywords: Scalp avulsion, Pentoxifylline, Case study, Graft survival, plastic surgery, oral and maxillofacial surgery

1. Introduction

A scalp avulsion is a rare but lethal injury that can potentially be fatal and frequently results in abnormalities of the skin that bears hair [1]. Even if a scalp injury seems benign at first, it requires a careful examination and critical assessment [2]. Harvey Cushing warned in 1918 that "though many scalp wounds that appear serious prove to be trifling, more that appear trifling prove to be serious.?" [3]. The scalp can be separated from the easily defined dissection plane in the periosteum by applying a large shearing force to the loose areolar tissue between the galea and periosteum [4], and the best kind of treatment for such an injury is early replantation. Patients who do not have their scalps replanted may need to have the raw areas of their skin grafted; however, this procedure can leave most patients with unstable skin cover in those areas, and healing may take several months. Thus, it is imperative to replant scalp avulsions in every possible way [5]. It is thought that early circulation establishment through direct vessel - to - vessel anastomosis between the recipient bed and the graft is essential for the graft's survival. But in cases of various graft failure, multiple surgeries have been reported, and to improve the survivability of grafts or replanted scalps, a pharmacological agent with the ability to boost vascularization is essential for such a condition [6].

Pentoxifylline, the first known hemorrhologically active drug, is a derivative of methyl xanthine with a range of anti - inflammatory properties [7]. It is a well - known, powerful agent that enhances tissue vascularization because it increases the flexibility of red blood cells and improves blood flow properties by lowering blood viscosity [8]. It enhances

microcirculation and oxygen delivery after these modifications, especially during ischemic states [9].

Necrosis results from injury to the subcutaneous vascular network in an avulsed area of skin. A graft that consists of both skin and subcutaneous tissue is called avulsed skin. [6]. Enhancing vascularization in a graft can improve blood flow and increase the survival rate of injuries developing in the skin. Pentoxifylline has a reputation for enhancing vascularization. [10]

Although many treatments and articles have been developed and published to date for replantation, microvascular anastomosis, and split - thickness grafts, they cannot lower the trauma of an individual related to disfigurement and psychological effects. The most common devastating side effect that occurs and also has a high psychological impact on one's life is baldness, which can only be cured with a wig. So we here present a rare case of scalp avulsion where management was done by reimplantation and postoperatively, followed by pentoxifylline to reduce postoperative side effects and increase the longevity of grafts.

2. Case Presentation

In a road traffic accident, a 17 - year - old female patient's long hair got trapped in a moving vehicle, and she presented to our institute's emergency department in India with a scalp avulsion injury. After a brief initial examination, it was discovered that the frontal bone was entirely exposed due to avulsed scalp tissue, which was only connected at the occipital nuchal line, facial lacerations of the forehead, and

bilateral supratarsal folds of the temporal region, which included both eyebrows and the right ear. [Figure 1]

She had a Glasgow score of 15, was conscious, oriented, was able to maintain her airway, and was hypotensive, which may be because hemorrhagic shock occurred at the time of injury. There were no reports of vomiting, nausea, or seizures. Her past medical history was irrelevant. Upon clinical examination, there were no visible fractures or bruises on her limbs, trunk, or cervical region. Initial management was done according to the ATLS protocol. Intravenous antibiotics were administered in addition to multiple blood transfusions. Anatomical repositioning of the scalp and facial lacerations was done, followed by the application of pressure dressings to achieve hemostasis.

Her laboratory investigations showed low levels of blood components: hemoglobin was 8.3 g/dl, platelets were $150 \times 10^3/\mu\text{l}$, and there was a slight elevation in total leucocyte count of $13.2 \times 1000/\text{cmm}$. Other laboratory tests were normal.

After hemodynamic stability, the patient was taken to the operating room for immediate replantation under general anesthesia. The wounds were thoroughly washed with normal saline to remove any dirt, foreign bodies, or oil. There were no vessels available for anastomoses, and this could lead to necrosis and disfigurement. The scalp that was attached to the occipital nuchal line was the only blood supply source available, as all other vessels were thrombosed and unavailable for any microsurgical repair. The wound was re-approximated, and suturing was done using 3/0 vicryl and 5/0 nylon. Scalp wounds were sutured using skin staples. Two days following the surgery, the forehead and right ear skin started blackening. [Figure 2], and the patient was planned for debridement and skin grafting. The patient was again transferred to the operating room for debridement and skin grafting. The necrosed skin of the forehead was debrided, and a split-thickness skin graft was harvested from the left thigh and placed over the forehead and right ear. A bolster dressing was given. Post-operatively, the patient was managed through intravenous antibiotics and was started on tab pentoxifylline 400 mg twice daily. Four days after surgery, the wound was opened, and the graft was seen to have survived well. After forty-five days of surgery, follow-up revealed healthy and uncompromised grafts and well-developed hairs. With no sensory loss. After one year of follow-up, hair growth was normal, the graft was well taken by the skin, and a patch of 5x3 had loss of hair in the occipital region, which was fully covered by long hair and was not visible [Figure 3].

3. Discussion

Scalp avulsion can be treated with a variety of replantation techniques to provide the best possible functional and aesthetic outcomes. Microvascular surgery, free flaps, hyperbaric oxygen, and skin grafting are all appropriate choices for reconstructive plans [11]. Miller et al. originally reported the technique of microsurgery to replant an avulsed scalp in 1976, and they attained a flawless outcome [12]. This case is particularly challenging because of her young age, hemorrhagic shock, thin vessel, high thrombosis occurrence

probability, several explorations, absence of any vessel available for anastomosis, and a shortage of skin donors, leading to a high probability of necrosis and baldness throughout life. We accomplished a near-perfect result with a lot of effort. Some experiences should be accentuated here to help us understand severe events in juveniles like this.

In the event that replantation was decided upon, we would need to gain insight into how the blood flows through the scalp, face, and ears and choose the most suitable vessel first [13]. On exploration of this particular case, we found that all the vessels were thrombosed and were not available for any microvascular surgery, leading to our biggest challenge: if blood supply is not restored, it would lead to the non-viability of a replanted scalp, as it is proven that cranial aponeurosis and the skull do not contribute any blood supply to the scalp.

In our case, after the necrosis of the forehead skin, we harvested the split skin grafts from the left thigh and placed them on the forehead. We were in dire need of any substance that could revascularize the graft and aid in its survival. Pentoxifylline was recognized as an active ingredient that enhanced vascularization [8].

Rheologically, it has three main effects: it reduces serum fibrinogen, diminishes platelet aggregation, and enhances erythrocyte flexibility without altering the coagulation profile. With these characteristics, it was speculated that it could serve as a beneficial agent in improving ischemic skin flap survival by minimizing blood viscosity [14]. Furthermore, pentoxifylline improves circulation by slightly lowering vascular tone [15]. Vasoconstriction and edema are common after flap surgery, and the former can further reduce vessel diameter due to locally released substances like thrombin and thromboxane A₂. Thus, pentoxifylline suppresses these endogenous substances' effects to some extent [16]. Pentoxifylline effectively eliminates hydroxyl radicals, which amass in tissues affected by ischemia. [17].

Enhancing vascularization in a graft can improve blood flow and increase the survival rate of injuries developing in the skin [10]. In order to evaluate the effectiveness of PTX (25 mg/kg/day as IP for 10 days) on skin-developing injuries, Oztuna et al. [6] created an experimental skin model for the first time. In rats receiving pentoxifylline, they saw full epidermis growth after ten days in both clinical and histopathological examinations. [6]. It is believed the reason for the increase in flap survival is pentoxifylline. In order to validate the pathophysiologic mechanism that keeps the random section of the skin flap from necrotizing [16]

4. Conclusion

In conclusion, pentoxifylline represents a breakthrough in scalp injury treatment, offering the potential to transform current practices. The positive impact on graft survivability, coupled with the hemorheological properties that stimulate blood flow, make pentoxifylline a game-changer in the field. Studies and clinical trials have highlighted the positive effects of pentoxifylline on promoting graft integration and wound healing in scalp avulsion cases. Currently, the management of scalp injuries is fraught with challenges, including poor graft

survival rates and limited options for improving outcomes. Pentoxifylline offers a novel solution that addresses these limitations, offering new hope for patients and caregivers alike. It is time to embrace this revolutionary approach and explore its full potential in clinical practice. However, further research and clinical trials are needed to fully elucidate the therapeutic benefits and optimal usage of pentoxifylline in this context.

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Conflict of Interest Statement

No conflict of interest present

References

- [1] Jiang Z, Li S, Cao W. Emergency management of traumatic total scalp avulsion with microsurgical replantation. *Ulus Travma Acil Cerrahi Derg.*2014 Jan; 20 (1): 66 - 70.
- [2] Haug, & Morgan, J. R. (1998). *Management of Scalp Injuries. Oral and Maxillofacial Surgery Clinics of North America*, 10 (4), 597–618.
- [3] Cushing H. Notes on penetrating wounds of the brain. *Br Med J.*1918 Feb 23; 1 (2982): 221 - 6.
- [4] Bhattacharya V, Sinha JK, Tripathi FM. Management of scalp injuries. *J Trauma.*1982 Aug; 22 (8): 698 - 702.
- [5] Sabapathy SR, Venkatramani H, Bharathi RR, D'Silva J. Technical considerations in replantation of total scalp avulsions. *J Plast Reconstr Aesthet Surg.*2006; 59 (1): 2 - 10.
- [6] Oztuna V, Eskandari MM, Unal S, Colak M, Karabacak T. The effect of pentoxifylline in treatment of skin degloving injuries: an experimental study. *Injury.*2006 Jul; 37 (7): 638 - 41.
- [7] Hassan I, Dorjay K, Anwar P. Pentoxifylline and its applications in dermatology. *Indian Dermatol Online J.*2014 Oct; 5 (4): 510 - 6.
- [8] Armstrong Jr M, Kunar DR, Cummings CW. Effect of pentox - ifylline on myocutaneous flap viability in pigs. *Otolaryngol Head Neck Surg* 1993; 109: 668—75.
- [9] Ahmadi M, Khalili H. Potential benefits of pentoxifylline on wound healing. *Expert Rev Clin Pharmacol.*2016; 9 (1): 129 - 42.
- [10] Urbaniak JR, Evans JP, Bright D. Microvascular management of ring avul - sion injuries. *J Hand Surg Am.*1981; 6 (1): 25–30.
- [11] Almoshantaf MB, Swed S, Hajjar A, Alshawaf A, Nabhan A, Zetani B, Etr A. Successful management of scalp avulsion with full - thickness graft. *Clin Case Rep.*2022 Jul 25; 10 (7): e6094.
- [12] Liu T, Dong J, Wang J, Yang J. Microsurgical replantation for child total scalp avulsion. *J Craniofac Surg* 2009; 20: 81 - 4.
- [13] Preis FWB, Urzola V, Mangano A, et al. Subtotal scalp reconstruction after traumatic avulsion: a technical note. *J Craniofac Surg* 2007; 18: 650Y653
- [14] Chu BC, Desmukh N (1989) The lack of effect of pentoxifylline on random skin flap survival. *Plast Reconstr Surg* 83: 315 - 318
- [15] Ward A, Clissold SP. Pentoxifylline: a review of its pharmacodynamic and phar - macokinetic properties and its therapeutic efficacy. *Drugs.*1987; 34: 50 - 97.
- [16] Williams PB, Hankins DB, Layton CT, Phan T, Pratt MF. Long - term Pretreatment With Pentoxifylline Increases Random Skin Flap Survival. *Arch Otolaryngol Head Neck Surg.*1994; 120 (1): 65–71.
- [17] Pasquier C, Franzini E, Abedinzadeh Z, Kaouadji MN, Hakim J. Gamma and pulse radiolysis of pentoxifylline, a methylxanthine. *Int J Radiat Biol.*1991; 60: 433 - 447.

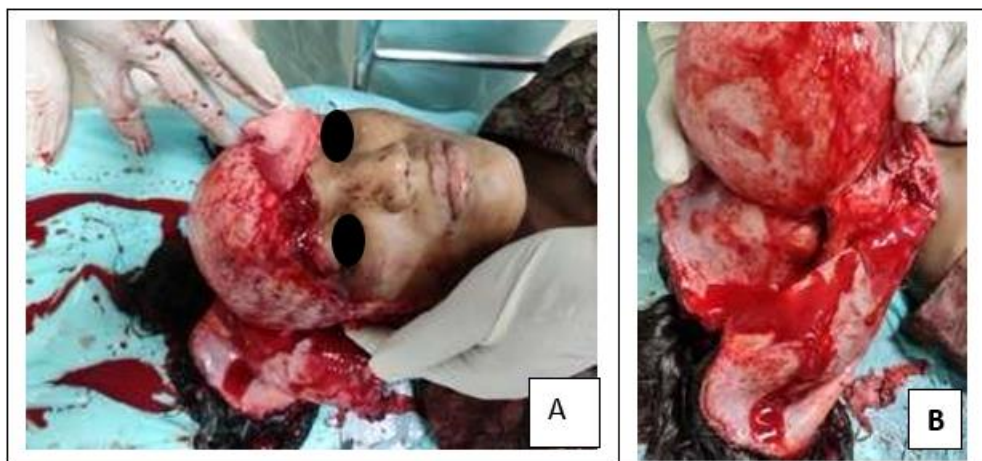


Figure 1: [A] facial lacerations of the forehead, eyes and ear. [B] Avulsed scalp attached at occipital nuchal line.

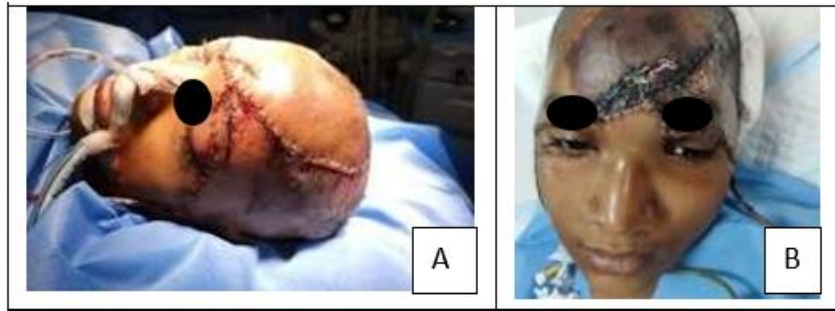


Figure 2: [A] reapproximated scalp with sutures on face [B] Blackening of facial skin postoperatively.



Figure 3: [A] survived graft on forehead [B] healed facial laceration with minimal scalp [C] alopecia present in occipital region. [C, D, E] one year post operative follow - up