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Original Research Article

RECONSTRUCTION OF POST ELECTRICAL BURN SCALP DEFECTS

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Abstract

Background: Electrical burns are potentially devastating injuries. Scalp defects following electrical burns present as a reconstructive challenge. The factors influencing decision-making in the repair of scalp defects are their size, depth and location, and integrity of surroundings. A successful reconstruction must result in less morbidity, decreased hospitalization time, and good aesthetic appearance preserving the hairline. The rationale for the study is to study the epidemiology of post-electrical burns scalp defects and to propose an algorithm for their reconstruction.

Methods: This retrospective study includes 95 patients with post-electrical burns scalp defects from Jan 2013 to Dec 2022. Patients admitted with scalp defects resulting from electrical injuries were initially resuscitated. Once deemed fit for surgery, they underwent wound debridement. Due to the progressive tissue necrosis associated with electrical burns, multiple debridements were necessary. Various methods were employed to reconstruct the scalp defects based on the specific nature of the defect, including primary closure, skin grafting, and the use of flaps. Follow-up visits were scheduled weekly for the first month and then monthly for the subsequent six months.

Results: 52 patients had pericranium intact for which SSG was performed. 43 cases had loss of pericranium for which local flaps were given in 36 cases. In 2 patients skin traction by stainless steel wires was done. Sequestrectomy + Tensor fascia lata Graft with Bipedicle Advancement Flap cover was done for a patient with osteomyelitis of bone. Regional Vertically placed Trapezius Myocutaneous flap was done in 3 cases and for one case Free Anterolateral thigh flap was given.

Conclusion: Reconstruction of post-electrical burn scalp defects should follow the reconstructive ladder. Reconstructive strategies are to be adapted based on defect size, depth, presence or absence of pericranium. If pericranium is intact - split-thickness skin grafting can be done. If pericranium is lost - a flap cover is to be given. Local flaps are the ideal choice for the reconstruction of scalp defects due to their easy availability, and minimal complications.

Keywords: Electrical burn, Scalp defects reconstruction, Skin graft, Local flap, Free flap.

Introduction

Electrical burns are potentially devastating. Scalp defects following electrical burns present as a reconstructive challenge. The severity of the damage depends on voltage, type of current, duration of contact, and tissue resistance The factors influencing decision-making in the repair of scalp defects are their size, depth and location, and nature of the defect [1]. the integrity of the surroundings [2]. Successful reconstruction results in less morbidity, decreased hospitalization time, and good aesthetic appearance, preserving the hairline. It must follow the reconstructive ladder. The rationale for this study was to study the epidemiology of post-electrical burn scalp defects and to propose an algorithm for their reconstruction. Reconstructive options for these defects include skin grafts, local flaps, and free flaps [3, 4]. As Gillies Principle states "Replace like with

like," so scalp defect should be reconstructed with adjacent tissue. The decision-making process behind a successful outcome requires solid knowledge of anatomy, a clear evaluation of the defect, the recognition of relevant patient attributes, and the knowledge of a variety of reconstruction options. Preoperative planning is imperative and must be specifically tailored to individual problems because no single solution is available for scalp reconstruction.

Material and Methods

This retrospective study includes 95 patients with post-electrical burns scalp defects from Jan 2013 to Dec 2022. Institutional Ethics Committee approval was taken, and individual informed consent was taken from each of the participants of the study.

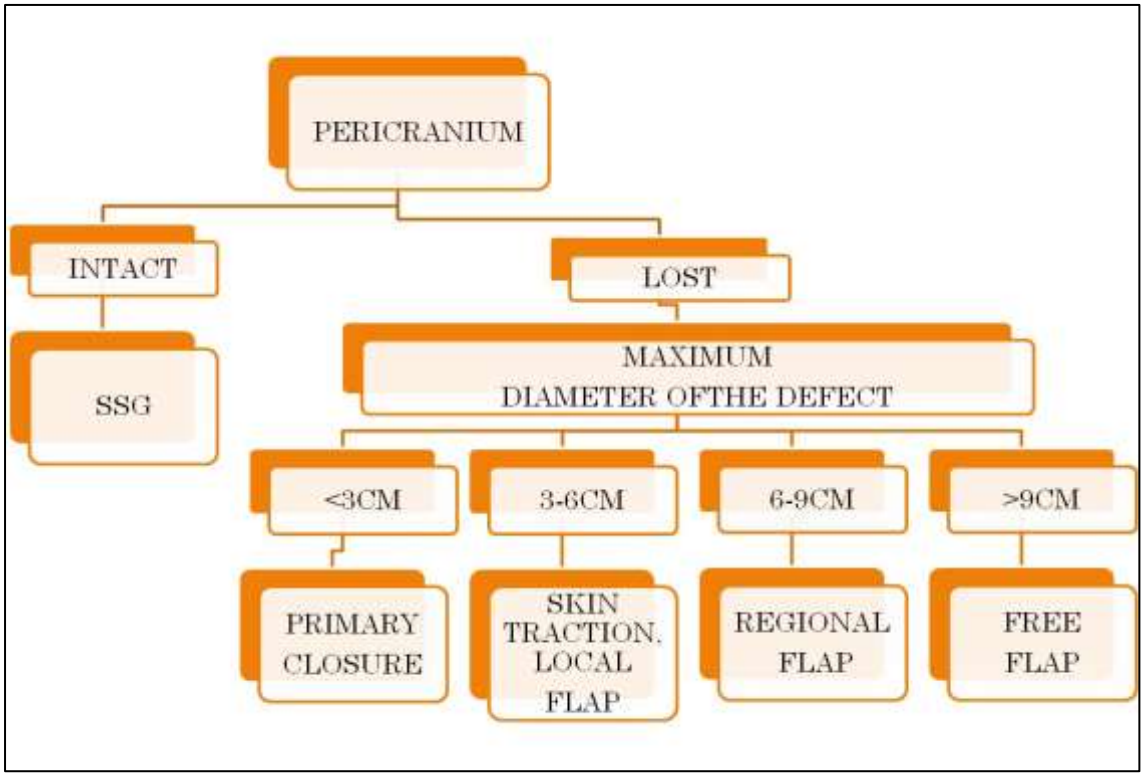
Inclusion Criteria

1. Patients with Scalp defects following electrical burns.
2. Males and Females
3. All age groups
4. Operated in our Hospital

Exclusion Criteria

1. Patients with polytrauma, head injury.
2. Patients not fit for surgery
3. Patients whose complete reports and follow up were not recorded

Patients admitted with scalp defects following electrical burns were resuscitated. Once the patient was found fit for surgery, was taken up for wound debridement. As progressive tissue necrosis is seen in electrical burns, serial debridements were required. Based on the scalp defect various methods were used to reconstruct the defect like primary closure, skin grafting, and flaps. Patients were followed up at weekly intervals for one month followed by once a month for 6 months.



Algorithm for reconstruction of post-electrical burn scalp defect

Results

The patients who were a part of this study ranged from 7 years to 56 years of age, with most of them falling in the age group between 21 to 30 years. (Table 1) The mean age was 29.0 ± 8.5 years. The patients in our series were mostly males numbering 89 (93.6%) and the rest 6 (6.4%) were females.

Table 1: showing the age group distribution of cases included in the study

Age group (in years)	*Frequency (%)*
<10	5(5.3%)
11-20	20(21.0%)
21-30	31(32.6%)
31-40	19(20.0%)
41-50	12(12.63%)
51-60	8(8.4%)
Total	95(100.0%)

The most common site involved was the temporoparietal region (36 cases, 37.9%) had the highest frequency of scalp defects, followed by the temporal region (16 cases, 16.8%) and the parietal region (15 cases, 15.8%). Frontoparietal (13 cases, 13.7%), frontal (6 cases, 6.3%), temporofrontal (2 cases, 2.1%), and occipital (7 cases, 7.3%) regions had proportionally fewer scalp defects. (Table 2)

Table 2: Site of post-electrical burns Scalp Defect

Site	*Frequency (%)*
Temporoparietal	36(37.9%)
Temporofrontal	2(2.1%)
Frontoparietal	13(13.7%)
Parietal	15(15.8%)
Frontal	6(6.3%)
Temporal	16(16.8%)
Occipital	7(7.3%)

Electrical current tends to follow the path of least resistance, which could explain the higher prevalence of defects in areas with abundant blood vessels and cerebrospinal fluid (CSF). The temporoparietal region is richly supplied by blood vessels, and the temporal bone houses CSF, making it a more conductive area. Scalp hair might offer some degree of protection against electrical current, potentially reducing the severity of burns in some areas like the frontal scalp. In our series, 52 (54.7%) patients had right-sided involvement, 35 (36.8%) patients had left-sided involvement, and in 8(8.4%) patients it was bilateral/central involvement. (Figure 1)

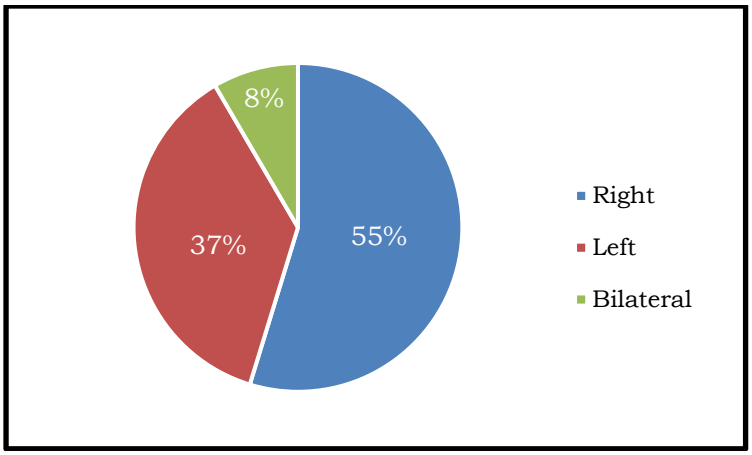


Figure 1: Side of Scalp Defect

N=43 had a full-thickness loss of the scalp including the pericranium and 52 patients had pericranium intact. (Table 3)**.** The maximum diameter of the defect was considered when calculating the size (Figure 1). It was measured separately for cases with intact pericranium (Table 4) and cases with loss of pericranium (Table 5) as the treatment options varied accordingly.

Table 3: Component Loss

Pericranium	Frequency	Percentage
Lost	43	45
Intact	52	55

Table 4: Size of the Defect with Intact Pericranium

Size (Maximum Diameter)	*With intact Pericranium*	
	Frequency	Operative procedure
<3 cms	9	SSG
3-6 cms	28	SSG
6-9 cms	13	SSG
>9cms	2	SSG

Table 5 details the relationship between the size of a scalp defect with pericranium loss and the chosen surgical procedure for repair. The size of the defect with pericranium loss seems to influence the chosen operative procedure. *Small Defects (<3 cm):* A single case underwent primary closure, which involves suturing the scalp edges together directly. *Medium Defects (3-6 cm):* The majority of cases (36) involved local flaps, where nearby scalp tissue is mobilized to cover the defect. Skin traction was used in 2 cases, a technique that stretches the surrounding scalp to achieve closure. *Large Defects (6-9 cm and >9 cm):* Regional flaps (3 cases) involve mobilizing scalp tissue from a broader area. A single case requires a free flap, which involves transplanting tissue from another part of the body.

Table 5: The size of the defect with loss of pericranium

Size (Maximum Diameter)	*Loss of Pericranium*	
	Frequency	*Operative procedure*
<3 cms	1	Primary Closure
3-6 cms	36	Local flaps
3-6 cms	2	Skin traction
6-9 cms	3	Regional Flap
> 9 cms	1	Free flap

Various reconstructive options such as split-thickness skin grafting (SSG) and local, regional, or free flaps were used. In 5 patients burr holes were done and after granulation, SSG was placed over it. In 1 case primary closure was possible. In 2 patients skin traction by stainless steel wires was done (Figure 3). Local flaps were planned in 36 patients such as Rotation flap (Figure 4), Transposition flap (Figure 5), and Double transposition flap (Figure 6). Regional Trapezius flap was done in 3 cases and Free Anterolateral thigh flap in 1 (Figure 8). Sequestrectomy + TFL Graft was done in one patient with osteomyelitis of bone after which a Bipedicle Advancement Flap cover was given.

Table 6: Operative Procedures

Operative Procedure	Frequency
Split skin grafting	47(49.5%)
Burr holes + Split skin grafting	5(5.2%)
Primary closure	1(1.0%)
Skin traction	2(2.1%)
Advancement flap	3(3.1%)
Bipedicle Advancement Flap	2(2.1%)
Rotation flap	4(4.2%)
Transposition flap + split skin grafting	23(24.21%)
Double Transposition Flap	2(2.1%)
Rotation to Transposition Flap	2(2.1%)
Trapezius Flap	3(3.1%)
Antero Lateral Thigh Free Flap	1(1.0%)

Figure 2: SSG over granulation

Figure 3: Use of Skin Traction for closure

Figure 4: Rotation flap was used to correct the scalp defect

Figure 5: Transposition flap

Figure 6 Double transposition flap

Figure 7: Vertically placed Trapezius Myocutaneous flap

Figure 8: Anterolateral Thigh Free Flap

Postoperative Complications: 6 patients had Marginal Flap Necrosis Which was debrided and reinset was given. 8 patients had partial loss of skin graft. (Table 7)

Table 7: Post-operative Complications

Time of Presentation	Number of Patients (%)
Marginal flap necrosis	6 (6.3%)
Partial graft loss	8 (8.4%)
No complications	81 (85.3%)

In the follow up we found no morbidity was found other than alopecia. Dog ears settled well. Follow-up of most of our patients was no more than three months as most of our patients are poor, illiterate, and hail from remote places and did not return for follow-up.

Discussion

The most common cause of deep scalp burns is electrical burns, and the severity of the burns is mainly determined by the duration of contact with the electrical source, the voltage of the current, and also by the resistance offered by the body structure in contact. High resistance is provided by the calvarium; therefore, electrical burns commonly involve the scalp. High-voltage (>1000 volts) burns are responsible for extensive tissue damage. The resulting injury usually appears as a circular area with central full-thickness damage of the

scalp, often reaching through the galea, periosteum, and sometimes bone. The dura is rarely involved. Early debridement and coverage of the defect yielded the best results. However, if the calvarium is exposed, vascularized tissue coverage provides better results and fewer complications. Scalp reconstruction differs from reconstruction elsewhere owing to the rigid and inelastic nature of the scalp. Electrical burn injuries primarily affect adult men and are often work-related. In our study maximum patients were in the 21-30 years of age group and 89 patients (93.6%) were male. The temporoparietal region was the most affected.

Simple and basic procedures should be considered for reconstruction first [5]. For small defects less than 3 cm in diameter and without hairline involvement, direct primary closure is the preferred approach due to its simplicity and minimal rate of complications [6]. To ensure tension-free closure, galeal-releasing incisions placed parallel to the incision should be considered. Primary closure was performed in one patient. Direct closure is suitable for defects that are less than 3 cm in diameter because of local tissue elasticity [7, 8]. Skin traction by stainless steel wires and daily twisting for slow approximation of wound edges was performed in two cases. SSG was performed in 52 patients (5 patients after trephination). Skin grafting is an easy technique with rapid healing properties when applied to a well-vascularized bed [5].

Different types of scalp flaps can be planned according to the size, localization, and shape of the defects, with fewer complications [5,7,9]. Planning with local flaps is challenging, as the amount of available scalp must be adjusted to avoid frontal alopecia. In our study, a flap cover was provided to 40 patients. Local flaps seem to be the best solution in small to medium-sized defects of the scalp as the use of these flaps avoids the technical difficulties and donor-site problems associated with microsurgical tissue transfer [5]. Free flaps are the current recommendation for the reconstruction of large scalp defects, as they bring reliable vascularized tissue [7,10,11]. They are reliable in cases where adequate local tissue is unavailable and for extensively large defects that involve the calvarium or hairless areas. Free flaps provide a single-stage, stable coverage with well-vascularised tissues [12].

Conclusion

The reconstruction of scalp burn defects should follow a reconstructive ladder. Reconstructive strategies should be adapted based on the defect size and the presence or absence of pericranium. Based on the collected and analyzed data, an algorithm for the reconstruction of post-electrical burn scalp defects was derived. If the pericranium is intact, then a split-thickness skin graft is ideal. If the pericranium is lost, the flap cover is given. Local flaps are the ideal choice for the reconstruction of scalp defects due to their easy availability, and minimal complications.

References

1. García del Campo JA, García de Marcos JA, del Castillo Pardo de Vera JL, García de Marcos MJ. Local flap reconstruction of large scalp defects. Med Oral Patol Oral Cir Bucal. 2008 Oct 1;13(10): E666-70.
2. Camelia Tamas, Lucian Popa, Dana Turliuc, C. Moroşanu et al. Surgical reconstruction *in* scalp defects. Jurnalul de. Chirurgie, Iasi. 2005*;* 1(2)*:*196-199.
3. Hilton CMH, Hölmich LR. Full- or Split-Thickness Skin Grafting in Scalp Surgery? Retrospective Case Series. World J Plast Surg. 2019 Sep;8(3):331-337.
4. Schonauer F, Abbate V, Dell'Aversana Orabona G, Salzano G, Sbordone C, Bonavolontà P, Somma T, D'Andrea F, Califano L. Hand Doppler flowmetry for surgical planning of pedicled flap in extensive full-thickness scalp reconstruction. Surg Oncol. 2020 Mar; 32:49-56.
5. Demir Z, Velidedeoğlu H, Celebioğlu S. V-Y-S plasty for scalp defects. Plast Reconstr Surg. 2003 Sep 15;112(4):1054-58.
6. Fowler NM, Futran ND. Achievements in scalp reconstruction. Curr Opin Otolaryngol Head Neck Surg. 2014 Apr;22(2):127-30.
7. Newman MI, Hanasono MM, Disa JJ, Cordeiro PG, Mehrara BJ. Scalp reconstruction: a 15-year experience. Ann Plast Surg. 2004 May;52(5):501-06.

8. Beasley NJ, Gilbert RW, Gullane PJ, Brown DH, Irish JC, Neligan PC. Scalp and forehead reconstruction using free revascularized tissue transfer. Arch Facial Plast Surg. 2004 Jan-Feb;6(1):16-20.
9. Spies M, McCauley RL, Mudge BP, Herndon DN. Management of acute calvarial burns in children. J Trauma. 2003 Apr;54(4):765-9.
10. Desai SC, Sand JP, Sharon JD, Branham G, Nussenbaum B. Scalp reconstruction: an algorithmic approach and systematic review. JAMA Facial Plast Surg. 2015 Jan-Feb;17(1):56-66.
11. Weitz J, Spaas C, Wolff KD, Meyer B, Shiban E, Ritschl LM. A Standard Algorithm for Reconstruction of Scalp Defects with Simultaneous Free Flaps in an Interdisciplinary Two-Team Approach. Front Oncol. 2019 Oct 25; 9:1130.
12. Lamaris GA, Knackstedt R, Couto RA, Abedi N, Durand P, Gastman B. The Anterolateral Thigh Flap as the Flap of Choice for Scalp Reconstruction. J Craniofac Surg. 2017 Mar;28(2):472-476.