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A Prospective Observational Study of Reconstruction of Post Electric Burn Scalp Defects

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Abstract
Background:
Post electric burn scalp defect reconstruction is a challenging endevour because of the variability in presentation for scalp defect. A useful reconstructive algorithm is not fully established. The purpose of our study was to evaluate our experience and to identify an appropriate reconstructive strategy.
Material and Method:
This was a prospective observational study, conducted in SMS hospital and NIMS hospital , Jaipur over a period of 2 ½ years from 2012 to 2015. Various modalities for reconstruction included skin grafting, bipedicle flap, rotation flap, transposition flap, extracorporial flap and free flap coverwere assessed in 80 patients.
Result: *Out of 80 paients, five developed complications in which four hadmild complications which were managed conservatively and one omental free flap got necrosedwhich was further managed with split thickness skin graft. Rest of all patients were discharged without any complication.*
Conclusion*: Important tenets for successful management of scalp defects are, adequate debridement with preservation of blood supply and proper wound drainage followed by a durable coverage. Local scalp flaps with skin grafts remain the mainstay of reconstruction in most instances.*
Key Word: *Electric burn, Scalp Defect and Reconstruction*

I. Introduction

Electrical injuries are potentially devastating injuries that result in injury to the skin as well as other tissues including nerve, tendons, and bone. Electrical burns can take several forms including injury from the electrical current itself along with flash burns, flame burns, contact burns, or a combination thereof.

Traditionally, electrical injuries have been divided into low voltage (less than 1,000 V) and high voltage (greater than 1,000 V). The considerations and management issues between the two are often different. Following electrical injury, it is important to assess the patient's airway, breathing, and circulation and stabilise the patient. Once stabilized, it is important to ascertain the circumstances surrounding the injury, the voltage of the injuring current, whether there was loss of consciousness at the scene, other associated injuries (i.e., fall from height), and whether there was a cardiac or respiratory arrest at the scene.

Actually it is the total current entering the human body which is of concern. All effects are based on the total amount which has entered into a human body. This was best described by Hodgkin in 1974. According to him 1mA of current leads to just tingling or perception which becomes painful when increased to 5 mA. At 60 mA, it leads to cardiac fibrillation, burns at 5000 mA and respiratory arrest at 10,000 mA.

When heart or brain comes in the path of a current, it is more likely to be lethal. Further, longer the duration of contact, greater are the chances of damage to the vital structures. Thus, a current passing from skull to feet is more lethal than a current passing from right upper limb to the right lower limb. Similar current passing from left hand to right hand will have more lethality because of involvement of heart in its path.

Nerves, designed to carry electrical signals, and muscle and blood vessels, because of their high electrolyte and water content, have a low resistance and are good conductors. Bone, tendon, and fat, which all contain a large amount of inert matrix, have a very high resistance and tend to heat up and coagulate rather than transmit current. The other tissues of the body are intermediate in resistance.[1]

Extensive deep destruction of the tissues may exist with high-voltage injuries, and the surface damage is often only "the tip of the iceberg" for these injuries.

The most destructive indirect injury occurs when a victim becomes part of an electrical arc. An electrical arc is a current spark formed between two objects of differing potential that are not in contact with each other, usually a highly charged source and a ground.

The scalp is unique as structure, shape and location. It is highest point of the body, most exposed and usually uncovered by clothing. These factors make it vulnerable burn injuries specially electric burns. Being exposed, mild degree of scarring is easily noticeable and lead to disfigurement. On the other hand the skin of the scalp lacks laxity and primary closure of wounds greater then 2 cm is often not possible. Anatomically, it is

described as an organ based on a rigid, flat aponeurosis and consisting in thick skin, penetrated by hair, nourished by a rich vascular network, situated in the subcutaneous tissue.[2]

Therefore the decision making process behind a successful outcome requires a solid knowledge of anatomy, a clear evaluation of the defect and the knowledge of a variety of reconstruction options available. Multiple reconstructive options exists that includes, primary wound repair, healing by secondary intention, and the use of skin grafts, local tissue flaps, regional myocutaneous flaps, and micro vascular free flaps. While considering reconstructive options the plan must always be tailored to the individual patient's needs and due attention be given to theaestheticoutcome that specially includes preservation of the hairline and hairfollicleorientation,scarcamouflage,avoidanceofalopecia,andsecondaryrestorationofalopecia.[3,4,5,6]

Tissue expansion has also emerged as one of the important modality for aesthetic scalp reconstruction after burn.[7]

Exposure and necrosis of bone may consequently lead to osteomyelitis and even an epidural abscess. Treatment strategies depend on the extent of the injury to the bone. In case of only a partial necrosis of the bone the outer table of the skull can be tangentially removed with a high-speed bone drillor a chisel hammer until fine punctate bleeding points are visible which indicates living bone. In case of sufficient vascularization the exposed bone can be grafted immediately or, when blood supply is questionable, grafted when suitable granulation tissue has developed.[8]

II. Materialand Method

This was a prospective observational study, conducted in SMS hospital and NIMS hospital , Jaipur over a period of 2 1/2years from 2012 to 2015. Reconstructive procedures, independent factors and outcomes were evaluated. Preoperative routine investigations were done in all patients like complete blood count, renal function test, liverfunction test, chest X ray and ECG.Non contrast CT Brain was performed when patient presented with history of unsciousness or convulsions. Various proceduresincluded skin grafting, bipedicle flap, rotation flap, transposition flap, pedicled medial arm flap,extracorporial flap and free flap cover were performed in 80 patients.

III. Result

Most of the patients in our study were males and sustained high tension electric burn injury. Out of eighty patient 69 were male and rest eleven are female patient.This reflects the fact that male while performing most of outdoor activities are more prone to electric burn injuries, and females of our society remain at home for domestic affairs are largely protected.

A multi staged surgical approach followed in all the patients. In the initial stage, wound debridement was performed in all the cases once area of necrosis is demarcated. Multiple dressings required before definitive procedure. Tetanus prophylaxis was ensured.

Single rotational flaps were performed in forteen patients. These flaps were raised based on major vessels. The flaps were raised through the sub galeal plane preserving the periosteum. In cases of circular defects, rotation flaps were used. In case of very large defect, transposition flaps with skin grafting were performed.

Age of presentation ranged from 10 to 50years and the most common age group is between 20to 30year and the second most common age group suffered is 30to 40year. Children were affected less as compared to other age groups.

Commonest performed is the transposition flap due to shape of scalp defect followed by rotation flap and free flap.Extracorporial and pedicled flapare rarely performed surgery when other options are not available. Drilling of outer table and grafting is an older technique but we didn't performed this procedure in any of the cases.

Case 1: A 12 year male child with large right temporoparietal post electric burn scalp defect covered with transposition flap (A B C D E)

A. Pre-Op

B. Intra-Op

C. Intra-Op

D. Post-Op

E. Follow Up

Case 2: A 26year male with large central forehead post electric burn defect covered with extra corporial forearm flap [Preop A&B, Postop C]

A. Pre-Op

B. Pre-Op

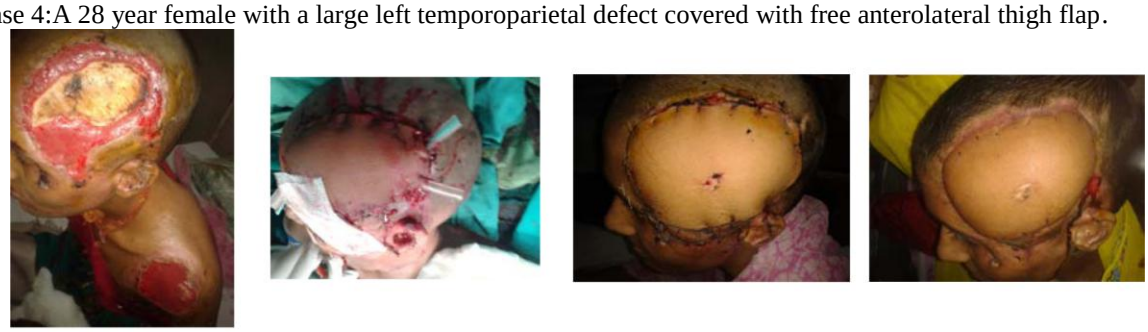
C. Post-Op

Case 3:A 36year male with circular defect left parietal scalp defect covered with rotation flap {Preop A, PostopB}

A. Pre-Op

B. Post-Op

Case 4:A 28 year female with a large left temporoparietal defect covered with free anterolateral thigh flap.



A. Pre-Op **B. Immediate Post-Op** **C. Day 10 Post-Op** **D. Follow-Up**

Out of 80 paients, five cases developed complications in which four cases hadmild complications ,which were managed conservativelyand one omental free flap did not survive and was debrided and later split thickness skin graft was performed. Rest of all patients progress was uneventful and discharged without any complication. Some patients on long term follow up presented with continuous discharge under the flap.They were evaluated and X-ray of skull was performed along with pus for culture sensitivity and later sequestrectomy was performed somewhere 3 months after flap reconstruction.

For this we wait till the sequestrum separate itself. Between this time period patients were kept on oral antibiotics. Then this sequestrated bonewas removed under local anaesthesia by raising the half of the flap and sutured again in position.Extracorporial and pedicle medial arm flap were performed in two patients because they gave negative consent for free flap and didn't wanted to compromise with remaining scalp tissue for local flap. Well settled extracorporial and pedicle medial arm flap not followed yet.

Table 1: Shows Age Distribution

Total no. of Pt	<10year	10-20year	20-30year	30-40year	40-50year	>50year
80	2	12	33	24	9	00

Table 2: Type of Coverage(Skin Graft/Local or Free Flap)

Total no.of Patient	**80**
Skin Graft	03
Extracorporeal Radial Forearm Flap	01
Pedicled Lateral Arm Flap	01
Rotation Flap	14
Transpositional Flap	57
Expansion and Advancement	00
Free Flap (Anterolateral Thigh Flap 02 Lattismus Dorsi Muscle Flap 01 Omental Flap 01)	04

IV. Discussion

In present era many techniues are available to reconstruct the scalp defect in which local option is chosen first then distant options like a free flap, either fasciocutaneous or myocutaneous or muscle with graft as they will help in future surgery like hair transplant especially in post burn alopecia which is most common complication.

The ideal timing for tissue debridement has similarly been controversial. The ideal time to determine the presence of myonecrosis is typically 3 to 5 days following injury and once area of necrosis is delineated. Therefore,early debridement might not be sufficient since irreversibly injured tissue may not have demarcated. At 3 to 5 days, all unhealthy tissue can be debrided and definitive wound closurecan be achieved at this time. Debridement of bone is performed at the time of definite flap coverage until fine punctate bleeding points are visible.

In case of forehead wounds, flaps were selected very carefully avoiding the hair bearing flaps.

The morbidity in all of these cases was not so much, however few of the complications like discharging sinus, exposure of bone, partial flap necrosis, partial graft loss and woundinfection were present. In one case of discharging sinus, cause was presence of sequestrum underneath the flap. The sequestrum was removed and flap re insetted and healed completely.

Similar studies were performed by Abdul Razzak Memon and his associates in Hyderabad.[9]. In another study, Newman and his colleagues performed scalp reconstruction in 64 patients over 15 years, the defectswere caused by multiple factors and the techniques of reconstruction were primary closure, skin grafting, local and distant flaps. In our study, we didperformed pedicled and free flap.

The scalp must be carefully searched for lesions as scalp burns are rarely painful and are easily missed on cursory physical examinations. Scalp burns which spare the galea are managed by excision and skin grafting directly onto the galea, while wounds that penetrate to the outer table of the skull or deeper require a different approach. Exposure of non-viable calvaria has historically been approached by providing a viable wound bed after removing the dead bone with an osteotome or saw. If drilling is required it should be multiple holes in a close set pattern, deep enough to cause bleeding from viable cancellous bone and it is a another method to develop granulation tissue which eventually covers the entire area. The latter method is still useful in situations where a patient's advanced age or large burn size precludes more aggressive approaches to wound closure. All of the above methods require weeks to months of wound care before the wound is ready for autograft coverage.For reconstruction, we used reconstructive triangle where centre is the scalp defect and three sides are denoted with split thickness skin graft, local flaps and microvascular free flaps[Fig :1].

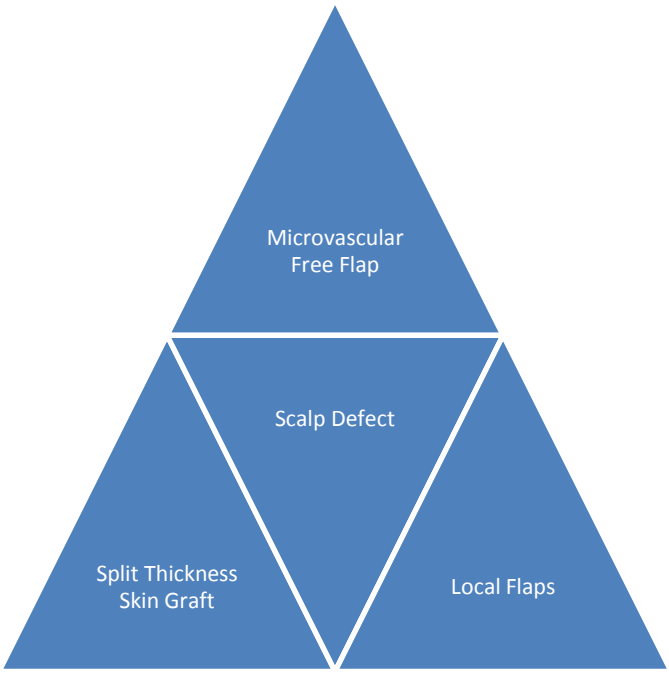


Figure 1: Reconstructive Triangle

Split-thickness skin grafts cover the resulting adjacent defect. This provides rapid closure and is associated with minimal morbidity.[10]Skin expansion of the hair-bearing area can be performed 12–18 months later to obliterate the areas of alopecia.

Another approach suggested is the partial debridement followed by definitive flap coverage of the exposed bone. This, however, requires early debridement and the prevention of localized bacterial colonization and infection.[11] Fortunately, involvement of the dura occurs rarely. This usually requires an extensive free flap procedure.[12] We preferably use the latissimus dorsi flap anastomosed to cervical vessels, occasionally using interpositional vein grafts. This reduces the risk of perfusion problems considerably. When these options are not available, the use of acellular human dermis to reconstruct the dural defect followed by split-thickness skin grafting after vascularization may be an option.[13]

The latissimus dorsi (LD) muscle has long been the flap of choice in reconstruction of extensive scalp defects. Its many attributes make it well suited for the role – a flat muscle of large surface area, a constant pedicle of good length and caliber, and negligible donor site morbidity. Scalp rotation flaps offer hair-bearing skin and are therefore superior in cosmesis, but their role is limited to non-irradiated small scalp defects. Although initially bulky and unsightly, the eventual aesthetics of an LD free flap following muscle atrophy and skin graft maturation is very acceptable.

V. Conclusion

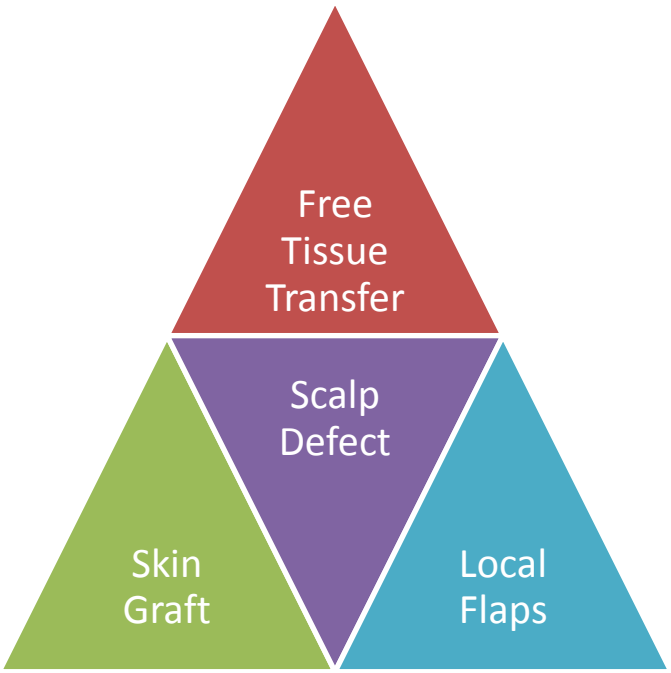
Adequate surgical debridement, removal of dead bone mainly outer cortex, meticulous surgical technique and selection of flaps are the mainstay of management. In this study, transpositinal flap and skin grafting were the preferable forms of reconstruction. Careful analysis of the defect and local tissues can help tailor the method of reconstruction and result in satisfactory closure in a majority of patients.Important tenets for

successful management of scalp defects are patient vitals, proper wound status,donor site of flap, adequate debridement, durable coverage & preservation of blood supply.Local scalp flaps with skin grafts remain the mainstay of reconstruction in most instances.

Drilling of outer cortex with grafting,pedicle lateral arm flap and extracorporeal radial forearm flap is old method and now a days is not preferable but can be used as salvage flaps when other options are not available.

Large defect which are not possible to be covered by local flap are best covered with free flaps either fasciocutaneous , muscle with skin graft or myocutaneous. The best and most expedient approach to deep skull burns is a rotation scalp flap over the burned area, although the choice of ideal flaps for reconstruction depends upon the size and site of scalp defect.

` All patients who sustain high-voltage electrical injuries should undergo a thorough neurologic evaluation at the time of admission and prior to hospital discharge.



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