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Role of Hybrid Reconstruction Ladder in Scalp Electrical Burn

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Abstract

The development of novel and inventive tissue regeneration strategies has been sparked by complex wound patterns. A multidisciplinary team has successfully adopted advanced reconstructive methods combined with modalities from regenerative medicine to enhance the results of difficult reconstruction. These procedures, known as "Hybrid reconstruction ladder," combine conventional reconstruction techniques with regenerative medicine applications. This review article provides a summary of the benefits of using a hybrid reconstruction ladder in scalp electrical burn.

Keywords: Hybrid Reconstruction Ladder, Scalp, Electrical, Burn, Management.

INTRODUCTION

Plastic surgery has undergone gradual evolution over time, the basic concept of methods of reconstruction ranked by complexity has been preserved and propagated in multiple forms. Most descriptions start with closure by secondary intention, followed by direct closure, local flaps, and distant flaps. Various authors have made finer distinctions among local, regional, and free flaps, and inserting tissue expansion somewhere in the spectrum.[1,2] The complex wound pattern has initiated efforts to create new and innovative techniques in tissue regeneration. Multidisciplinary team has effectively adapted advanced reconstructive techniques merged with regenerative medicine modalities to improve outcomes. These treatments combine traditional reconstruction measures with regenerative medicine applications and has been termed hybrid reconstructions. The hybrid reconstruction model (Figure 1) aids in maximizing the function while minimizing the disability and morbidity associated with traditional reconstruction.

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MATERIALS AND METHODS

This study was done at tertiary care hospital after obtaining approval of departmental scientific and ethical committee. Informed consent was obtained from the patient.This is a prospective descriptive non randomised case study about a 45 year old male sustained electrical burn injuries while working at construction building. He sustained electrocution by contact with electric wire as it fell on patient head. Patient initially went to local hospital, then arrived to our emergency

department with an electrical burn in the vertex region of the scalp (entry zone) and the left leg (exit zone). The Scalp had a contact with a 220 V of alternating current. It was presumed that the current entered his skull and exited through his left foot. The other external skin injury to scalp, chest wall, abdomen and both thighs and left foot. At the time of admission his Glasgow Coma Scale score was 12. The patient was disoriented and unconscious at the time of admission and patient was intubated. Multiple second-degree superficial burns involving face, neck, chest and abdomen (anterior aspect), bilateral arms (anterior aspect), bilateral thighs, multiple blisters over thigh, legs and second-degree burns involving frontoparietal region of scalp at the vertex (figure 2). The mid-frontoparietal scalp was charred. CT skull showed small ill-defined hypodense area with loss of grey white differentiation noted in the left frontal region- suggestive of left frontal infarct. The serum electrolytes, urea and creatinine, urine analysis, and electrocardiogram were normal, urine myoglobin negative. He was resuscitated with the standard WHO burn protocol. Patient was a symptomatic with no seizures, syncope, focal neurological deficits. He was managed conservatively with prophylactic antiepileptic Phenytoin. The patient was extubated after three days of intensive care. According to the manual muscle test, both upper and lower extremities were normal. Sensory function was intact, muscle stretch reflexes were normoactive, no pathological reflexes were identified, and all the other cranial nerve and cerebellar functions were normal. The electrical burn will undergo progressive skin necrosis, so the debridement was done after demarcation of necrotic patch. The dermabrasion is done using the high-speed rotating head dermabrader with 4200rpm. The non-viable necrotic tissue was debrided without damaging the normal tissues in both horizontal and vertical planes with dermabrader (figure 3). After wound debridement with derma-abrasion was done till the removal of unhealthy tissues. The end point of dermabrasion assisted debridement of scalp bone till the removal of necrosed top layer of bone and the bleeding point appears over the skull bone (figure 4). After debridement biological Human amniotic membrane (figure 5) and collagen scaffold dressing (figure 6) done. During wound debridement we have used low level laser therapy (figure 7) session for 10 minutes once in five days to the scalp wounds. Dermabrasion, low level laser therapy, biological human amniotic membrane with collagen scaffold dressing and cyclic Negative pressure wound therapy (figure 8) can be done with local anaesthesia. Post procedure patient need closed dressing system like NPWT (negative pressure wound therapy) for improving granulation and for preventing infection (figure 9). Once the wound bed showed healthy granulation, perforator-based type 4 keystone flap was done (figure 10).

RESULTS

The scalp wound with exposed bone was covered with adequate granulation tissue by the regenerative techniques followed by keystone perforator flap cover done in our case. Patient was compliance with all the above techniques we have used for regeneration of exposed scalp bone. No complications were noted post procedure. There was no complication associated with the flap and the skin graft applied. Both flap and skin graft were healthy without any necrosis after 2 weeks (figure 11). Patient discharged successfully.

Figure 1: Hybrid reconstruction ladder

Figure 8: Negative pressure wound therapy

Figure 4: Post dermabrasion assisted debridement till the appearance of bleeding points

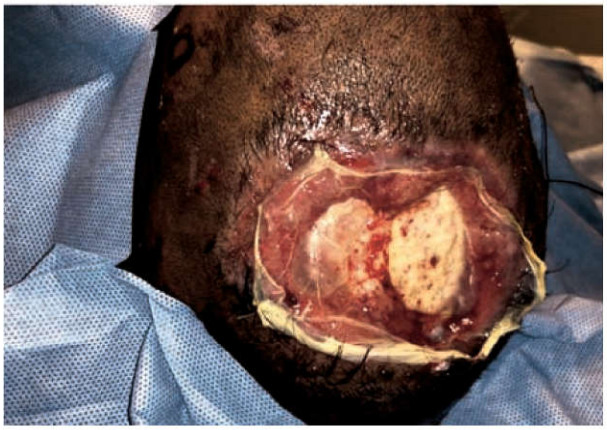

Figure 5: Human amniotic membrane application

Figure 6: Collagen scaffold application

Figure 7: Low level laser therapy

Figure 2: Scalp electrical burn wound at presentation

Figure 9: Well granulated electrical burn scalp wound

Figure 10: Keystone perforator flap POD 1

Figure 11: Keystone perforator flap post 2 weeks

DISCUSSION

The reconstructive ladder was a term coined by plastic and reconstructive surgeons to describe levels of increasingly complex management of soft tissue wounds. Theoretically, the surgeon would utilize the lowest part of the ladder – that is, the simplest reconstruction technique – to address a clinical reconstructive problem. The reconstructive surgeon would move up the ladder as a more complex or suitable method was required for a given reconstruction problem.[3,4,5] In this case as the patient is a case of scalp electrical burn with exposed scalp bone post wound debridement. The patient initially underwent regenerative therapies for improving granulation over the wound followed by local keystone flap cover based on perforator. A hybrid reconstructive ladder that augments the traditional reconstructive ladder with regenerative medicine modalities. There were improved outcomes at each step on the reconstruction ladder and these modalities may allow for the expansion of indications for each step on the reconstruction ladder. The study effectively employed dermal regenerates, soft tissue regeneration techniques, biologic scaffolds6, fat grafting techniques and adipose-derived stem cells in a number of reconstructions. Dry collagen was used as a scaffold for tissue regeneration of the wound bed for further intervention.[6,7] Prolotherapy believe that the injection of hypertonic dextrose causes cell dehydration and osmotic rupture at the injection site that leads to local tissue injury that subsequently induces granulocyte and macrophage migration to the site, with release of the growth factors and collagen deposition. In vitro studies have shown that even concentrations as low as 5% dextrose have resulted in the production of several growth factors critical for tissue repair. Some of these growth factors include PDGF, TGF-β, EGF,

b-FGF, IGF-1, and CTGF.[8] The reconstructive grid is a dynamic construct that takes into account the multiple reconstructive options available to the plastic surgeon. It also takes into consideration factors that help the reconstructive surgeon determine the best possible option to achieve the three reconstruction goals, namely, form, function, and aesthetics. The factors that aid the judgment of a reconstruction specialist, including wound complexity, surgeon skill, resources (and technology) available, and patient requests, form the boundaries of the reconstructive grid. Low Level Laser Therapy (LLLT) is one of the proposed modalities to improve wound healing and scar quality. LLLT is claimed to increase collagen synthesis, decrease inflammation and has a positive impact on scar remodeling. Negative Pressure Wound therapy (NPWT) involve removal of exudates and infectious materials and contraction of wound margin. NPWT has been shown to be safe and effective in post debridement wounds.[9] Hence NPWT was started, and size of the wound was measured at the time of change of dressing. Platelets act as regulators of inflammation, angiogenesis, cell migration, and proliferation with the release of various growth factors and anti-inflammatory cytokines which is thought to help in faster and better healing of the wounds. Autologous platelet rich plasma (APRP) has growth factors which when injected in the wound site or sprayed, act at the intracellular level to bring about cell proliferation and healing of a wound. All extracts of Centella asiatica facilitate the wound healing process in both incision and burn wounds. Asiatic acid in the ethyl acetate extract seemed to be the most active component for healing the wound.[10] Keystone is a peg shaped, main stone which supports the arch in Greek architecture. Because of the shape the flap designed, it is known as keystone flap. There are various types that have been described.[11]

Type I

The standard flap design and closure is suitable for defects over most areas of the body up to 2 cm in width

Type IIA: Division of deep fascia

For larger areas of reconstruction, located over the muscular compartments, the deep fascia over the muscular compartment is divided along the outer curvature of the flap to permit furthermobilization of the keystone flap

Type IIB: With split skin graft to secondary defect

Where excess tension exists, the secondary defect may be skin grafted

Type III: Double keystone flaps

For considerably larger defects (5–10 cm) a double keystone design can be done to exploit maximum laxity of the surrounding tissues.

Type IV: Rotational keystone flap

Occasionally to facilitate rotation across a joint contractures or compound fractures with exposed bone, the keystone flap is raised with undermining up to 50% of the flap subfascially. The perforator support is derived from the attached part of the flap.

Keystone flap was initially described for lower extremity defects.[11] There have been reports of the used of this design for trochanteric pressure ulcers. Since our patient had partial recovery of paraplegia, he walks with support and can be in sitting position for long time. This has led to ischial pressure ulcer. A versatile flap was required, which covered the bony prominence. As he had recurrent pressure sore, it was thought to be prudent to preserve the muscular flaps for future. We have used the type 4 keystone perforator flap forthe scalp defect since we felt the fascio-cutaneous flap would give an adequate cover and also leave the other options as our life boat flap. We have found this flap is easy to design. The donor site was skin graftedprimarily.

CONCLUSION

The application of regenerative medicine therapies in the treatment of complex reconstruction in scalp electrical burns has significantly aided in improving reconstructive outcomes. Hybrid reconstruction ladder is continuing to evolve and may become the standard of care for effective management of composite tissue wounds. This has to be applied to the multiple number of cases for the assessment of the hybrid reconstructive ladder.

Conflicts of interest: None

Authors' contributions: All authors made contributions to the research, is putatively expected to be useful article.

Availability of data and materials: Not

applicable.

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