



Plastic Surgery

APPLICATION OF 'RECONSTRUCTIVE LADDER' IN THE MANAGEMENT OF BURN WOUND

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ABSTRACT Burn wound closure requires a good understanding of the wound, its anatomy, physiology and the phases of wound healing. Improvement of general condition & nutritional status, infection control proper and prompt nursing care are all important elements in achieving good wound cover. This goal is achievable only through the interdisciplinary approach towards burn wound healing. The armamentarium includes a variety of techniques from conservative management to reconstructive techniques using the "reconstructive ladder". This article summarises the components of the reconstructive ladder for burn wound closure that are available to the reconstructive surgeon.

KEYWORDS : Burn wound, Reconstructive ladder, skin graft for burn wounds, local flaps in burns, regional flaps in burns, distant flaps in burns, free flaps for burn wounds.

Introduction

Burn injuries result from a variety of causes and present in varied types. These injuries cause significant morbidity and mortality. Effective and appropriate therapeutic intervention reduces the morbidity and mortality and improves their survival. Getting a superior functional and aesthetic outcome, returning back to society as a useful individual, surgeons encounter many surgical challenges while managing burn injuries. The whole armamentarium of plastic surgery should be kept in mind while managing the burn wound.

Materials and methods

It is a retrospective clinical study of patients admitted with burns in the Department of Burns, Plastic and Reconstructive Surgery at Kilpauk Medical College and Hospital, from January 2015 to December 2015.

All patients admitted with burns of less than 40%, who survived, were included in the study. They were treated initially with resuscitation and then the wounds were managed. An analysis was made about the various methods of burn wound management and the results of the treatment were also analysed. A total number of 556 patients had sustained less than 40 % burns, and 484 patients survived. Hence the analysis was done only for the patients who survived and were included in the study.

Results

484 patients were studied in respect to the method of reconstruction of the acute burn wound. Among the 484 patients, 170 patients were adult males, 241 were adult females, while 73 patients were children (Fig 1).

The age groups of the patients was analysed. There were 55 patients in the 1-10 yrs age group, 108 in the 10 – 20 years category, 133 patients in the 20 – 30 years age group, 103 in the 30 – 40 years age group, 46 in the 40 – 50 years group and 39 patients in the above 50 years age category (Fig 2).

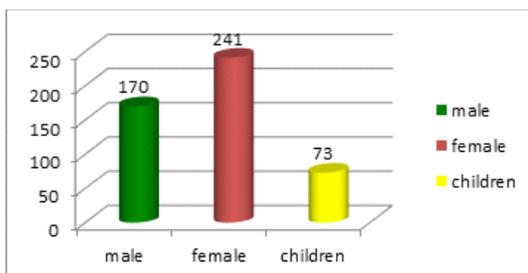


Fig 1: Sex distribution of patients included in the study

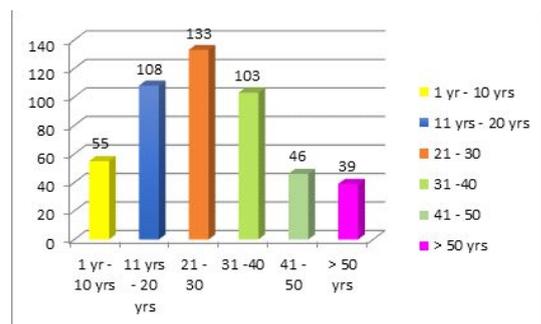


Fig 2: Age distribution of patients included in the study

The reconstructive method of treatment used in these patients was analysed (Fig 3). Though the reconstructive ladder includes only full thickness loss, we have considered even the management of second degree burns, as they can become full thickness loss, if the treatment is not adequate, and infection supervenes. 194 patients were mainly superficial II degree burns, and were treated with dressings alone. Collagen sheet application was done for 107 patients, who had uniform II degree burns, especially scalds. Skin grafting, either done as early excision and skin grafting, or done after the phase of infection, was done for 145 patients. Primary closure for full thickness loss in burns was done in 3 patients. Local flaps like rotation flap, transposition flap, were done for 12 patients. Regional flaps were done for coverage of full thickness loss following burns, in 10 patients. These regional flaps included Posterior Interosseous artery flap, Reverse Sural artery flaps. Distant flaps like the abdominal flap, groin flap were used for reconstruction in 9 patients. Free flaps were used in 4 patients.

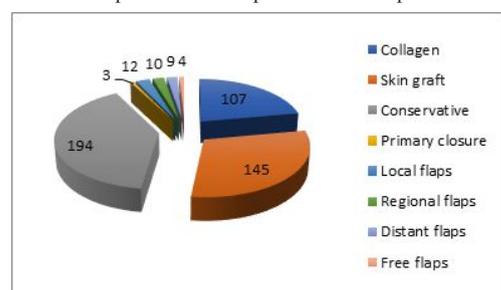


Fig 3: Analysis of different reconstruction methods in burn wound management

Discussion

Burn wound ranges from superficial burns to deep wounds as caused by electrical energy. The management of burn wound also ranges widely from conservative management with silver sulphadiazine dressing to collagen application, early excision and skin grafting, wound debridement and grafting to flap cover¹. Flaps may be local, regional, distant or free flap depending upon the wound status and availability of local tissues around the burn wound.

The reconstructive ladder

In this study, we mainly concentrated on selection of surgical plan depending upon the degree of burns and the availability of local surrounding tissues. Following the reconstructive ladder, the first consideration was conservative management, which consisted of silver sulfadiazine dressings for 5 days, followed by Soframycin cream application for 2 weeks. If proper management of II degree burns is not instituted, they can become deeper and result in full thickness loss. Hence, this method of prudent conservative management also forms part of the reconstructive ladder as far as burns treatment is considered.

Conservative management (Fig 4)

Of the 484 patients studied, 194 patients had conservative management of the wounds. When the patients were admitted, according to the Department protocol, assessment of the percentage burn area was done, recorded and resuscitation followed with the modified Parkland regimen of 3 ml/kg/% Burn. Silver sulfadiazine application was done for all the wounds, irrespective of the depth. Of these patients, 137 patients underwent a preliminary procedure of cleaning of the wounds under anesthesia, on the 10th to the 15th days. The time taken for the healing was 14 days +/- 2 days. First degree and superficial second degree wounds usually heal by 10 -14 days². These are managed conservatively by application of topical creams like silver sulphadiazine mupirocin, soframycin etc., followed by epidermal growth factor as ointment or cream. According to the Institution protocol, Collagen membrane was applied for burn wounds that were uniform II degree, like the scalds wounds.



Fig 4: Healing of superficial burns (a) Dressings only (b) Collagen application

Primary closure (Fig 5)

Primary closure of the wound was possible only in localised full thickness burn wound that was seen in 3 patients, following household electrical injuries, especially those with contact with wet electrical wires. Linear or elliptical wounds were closed primarily by bringing together available lax surrounding skin.



Fig 5: Primary closure for linear full thickness defects

Skin grafting (Fig 6)

Skin grafting can be done after early excision, tangential excision, escharectomy, for post burn raw areas and residual raw areas in patient with burns. Skin grafting was done in 145 patients. Early excision and grafting was done in 22 patients. It can be done after 48 hours and within 5-7 days. <30 % TBSA can be safely excised early and grafted³.

Advantage of early excision and grafting is early wound cover and early recovery leading into reduced hospital stay. Intensive post operative monitoring of the patient is mandatory after early excision and grafting.



Fig 6: Healing of deep burns with skin grafts (a) Early excision and skin grafts (b) Delayed grafting

Local flaps (Fig 7)

Burn wounds exposing underlying bone, tendon and vessels need flap cover. Local flaps can be used when the surrounding area is healthy. Local flaps can be axial or random pattern. Usually donor area need split skin grafting⁴. Local flaps like the rotation flap and transposition flap were done in 12 patients. 10 patients had electrical burns on the scalp, while one patient had a burn on the lower jaw and another had a burn on his leg.



Fig 7: Local flaps for full thickness burns (a) Rotation flap (b) Transposition flap (c) Limberg flap

Regional flaps (Fig 8,9,10)

In our study, 10 patients had a reconstruction for full thickness loss, with regional flaps. Regional flaps are indicated in full thickness burns exposing bone, tendon and vessels, where there are no adjacent healthy tissues available. Regional flaps are usually axial pattern. The flaps used in our series, were the delto-pectoral flap, pectoralis major myocutaneous flap, latissimus dorsi myocutaneous flap for the head and neck areas, cross finger flap and posterior interosseous artery flap for defects on the fingers and hands, and reverse sural artery flap and the propeller flap for localised burn wounds like electrical burns or the silencer contact burns on the lower limbs.



Fig 8: Regional flaps for burn reconstruction (a) Deltopectoral flap (b) Pectoralis major myocutaneous flap (c) Latissimus dorsi myocutaneous flap



Fig 9: Regional flaps for burn defects on the hand and upper limb (a) Cross finger flap (b) Posterior interosseous artery flap



Fig 10: Regional flaps for reconstruction of burn defects on the lower limb (a) Reverse Sural artery flap (b) Propeller flap

Distant flaps (Fig 11)

In our series, distant flaps were used for reconstruction in 9 patients. Distant flaps are advocated in full thickness burn wound exposing underlying vital structures where the surrounding area is unhealthy. These flaps are usually axial or random pattern flap like cross leg flap⁵.



Fig 11: Distant flaps for burn wound reconstruction on the limbs (a) Abdominal flap (b) Groin flap and abdominal flap (double flap) (c) Cross leg flap

Free flaps (Fig 12)

Free flaps were done for 4 patients in our series. The free flaps used were the anterolateral thigh flap and the latissimus dorsi muscle flap. In deep wounds non availability of regional or local tissues free flap is an available option which needs technical expertise, requisites equipments and specific instruments⁶.



Fig 12: Free flaps for electrical burn defect on the heel with anterolateral thigh flap

Conclusion

The reconstructive ladder⁸ usually used as a guide for reconstruction of full thickness defect in the skin. However as for as burns is concern even superficial second degree burns which are technically not full thickness loss can get downgraded to a deep second degree wound or deep second degree wound can get downgraded to a full thickness loss. Hence correct management of second degree burn must be instituted if it has to heal on its own. According to our study management of these superficial burns was done with conservative dressings or with collagen application and hence conversion to full thickness loss was prevented. Hence it would be appropriate to say that even conservative management of second degree burns should form a step in the reconstructive ladder.

Most flame burns with deep wounds had reconstruction with skin grafts . Some types of burns like electrical burns, chemical burns, contact burns required that the reconstruction be done with a higher step in the reconstructive ladder like flap cover. Some patients with deep second degree burns though would heal on their own needed a skin grafting which was one of the basic steps of the reconstructive ladder to ensure quick healing and cosmetically acceptable scars.

Applying the basic principles of plastic surgery as thinking in terms of reconstructive ladder in management of burn wound will minimise the morbidity and mortality. This study was done to prove that proper planning and carrying out the procedure meticulously place an important role in the management of burn wound.

Table 1: Algorithm for burn wound reconstruction using the reconstructive ladder

Serial No	Type of reconstruction	Indication
1.	Primary closure	Linear / Elliptical full thickness burn wound
2.	Skin graft	Healthy granulating raw area without exposing undelying bone, tendon & neurovascular bundle
3.	Local flap	Full thickness burn wound exposing bone, tendon and neurovascular bundle with healthy local tissues
4.	Regional flap	Full thickness burn wound exposing vital structures without healthy local tissues
5.	Distant flap	Full thickness burn wound exposing vital structure without healthy local and regional tissues
6.	Free flap	Full thickness burn wound exposing vital structures without available local and regional tissues

Appropriate reconstruction is of utmost importance for the aesthetic and functional outcome which improves the quality of life of the patient who has sustained burns.

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