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Application of Hybrid Reconstruction Ladder in Pediatric Scald Burn

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ABSTRACT

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 aids in maximizing the function while minimizing the disability and morbidity associated with traditional reconstruction.

KEYWORDS

• Hybrid Reconstructive Ladder • Scald Burns.

INTRODUCTION

The reconstructive ladder is a concept familiar to all plastic surgeons. Although it 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.

The complex injury 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'.[1]

The hybrid reconstruction model aids in maximizing the function while minimizing the disability and morbidity associated with traditional reconstruction. In aim of this study is to apply the hybrid reconstructive mole in our patient with a non-healing wound in the left knee.

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MATERIALS AND METHODS

The study was carried out in a tertiary care hospital in South India after receiving approval from departmental ethical committee. Informed consent was obtained for examination and clinical photography. 1year old male child presented with accidental scald burns which was second degree superficial and deep(mixed) burn over right upper limb and anterior chest and abdomen (figure 1). A hybrid reconstruction approach was carried out for his scald burn management. He underwent tangential excision and wound bed preparation like autologous platelet rich plasma (figure 2) followed by skin grafting, pixel grafting (figure 3) and cyclic negative pressure wound therapy (NPWT) (figure 4).

Figure 1: scald burn at the time of presentation

Figure 2: wound bed preparation using autologous platelet rich plasma

Figure 3: wound bed preparation using autologous platelet rich plasma

Figure 4: cyclic negative pressure wound therapy

RESULTS

In this patient, Hybrid reconstruction ladder approach helped in complete healing of the second degree superficial burn and in second degree deep burn, it helped to wound bed preparation and good take of skin graft (figure 5).

Figure 5: results of hybrid reconstruction ladder approach

DISCUSSION

The reconstructive ladder is an improper extension of a well-known and appropriate concept of a wound closure ladder. It has its own limitations. Although there is virtue in using the simplest solution to a given problem, at times more complex methods of reconstruction may be preferred, even when simpler methods can achieve wound closure. To address these concerns, several modifications to the reconstructive ladder have been proposed. Mathes and Nahai[2] suggested the "reconstructive triangle," which consisted of tissue expansion, local flaps, and microsurgery.

Gottlieb and Krieger[3] introduced the "reconstructive elevator" which, although still acknowledging the concept of increasing levels of complexity, suggests the freedom to ascend directly to the appropriate level if necessary.

Wong and Niranjan[4] recommended that the rungs be thought of as stages in the development of surgical skills, emphasizing that the difficulty of a reconstructive problem is related to the skill and training of the treating surgeon. Erba *et al.*[5] integrated the concepts of surgical risk, technological complexity, and surgical complexity into a matrix to help organize the various reconstructive methods and provide a framework for further discussion.

The reconstructive grid[6] 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.

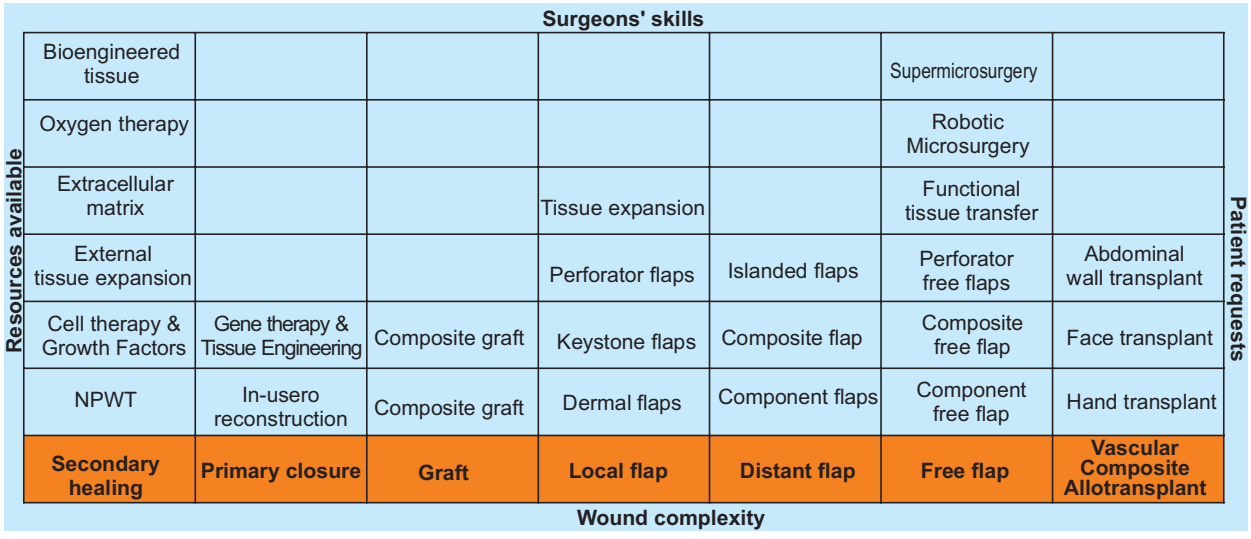

Figure 6: Source @ Viewpoints - Reconstruction 2.0: Restructuring the Reconstructive Ladder in Journal on Plastic and Reconstructive Surgery

The bottom row of the reconstructive grid houses the traditional modalities of reconstruction that are available in the ladder and elevator and the newer reconstruction modality, vascular composite allotransplant which, though absent in the reconstructive ladder, is mentioned in the modified reconstructive elevator[7]. The boxes above these primary reconstruction modalities show techniques available within each modality of reconstruction. The spatial nature of the reconstructive grid permits the specialist to select multiple options for a given defect. The reconstructive grid includes newer wound healing techniques such as bioengineered skin, cell therapies (e.g., adipocyte derived stem cells), and also still-developing reconstruction techniques including tissue engineering[8] and gene therapies[9]. The blank boxes represent available space to accommodate newer techniques as they arise, under each modality, thus making the grid future-ready.

The standard treatments for extremity injuries with massive composite tissue loss (bone, skin, soft tissue, nerves) require a spectrum of therapies. These therapies include extremity amputation, limb-shortening to assist in residual limb soft tissue coverage, free tissue transfers, pedicle flaps, local flaps, skin grafting, bone reconstruction, nerve repair or reconstruction and vascular repair. The traditional therapies may subtract from an already decreased functional capacity and may result in significant donor site morbidity. Revised amputations may have non-pliable and/or nondurable surface areas prone to erosive wear with prosthetic use. Furthermore, the multiple limb injuries and amputations seen in combat casualties typically involve expanded zones of injury that extend beyond the directly affected extremities that can complicate reconstructive efforts.[7] Furthermore, in the multiple extremity-injured service member, the common accepted donor sites for autologous tissues become increasingly limited.

Consequently, this has led to increased use of regenerative medicine modalities to enhance tissue regeneration and improve reconstructive outcomes. Hence the term "Hybrid Reconstruction Ladder". (Figure 5)

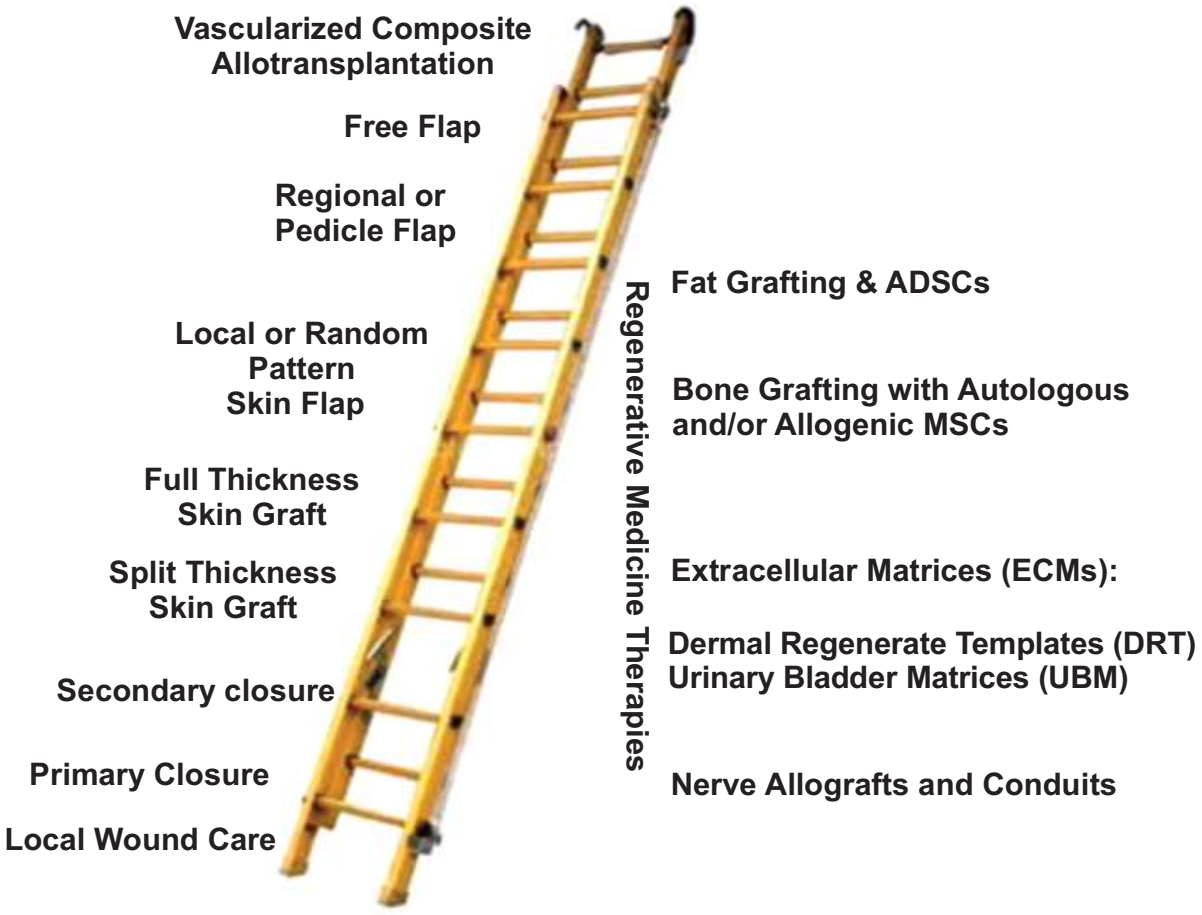

Figure 7: Source@ Article - Plastic Surgery Challenges in War Wounded II: Regenerative Medicine

The reconstructive ladder was a term coined by plastic and reconstructive surgeons to describe levels of increasingly complex management of soft tissue wounds.[10] Theoretically, the surgeon would utilize the lowest rung of the ladder that is, the simplest reconstruction technique to address a clinical reconstructive problem.[11] The reconstructive surgeon would move up the ladder as a more complex or suitable method was required for a given reconstruction problem. A hybrid reconstructive ladder that augments the traditional reconstructive ladder with regenerative medicine modalities.[12] There were improved outcomes at each rung on the reconstruction ladder and these modalities may allow for the expansion of indications for each rung on the reconstruction ladder.

The study effectively employed dermal regenerates, soft tissue regeneration techniques, biologic scaffolds, fat grafting techniques and adipose-derived stem cells in a number of reconstructions.[13]

Indications

The utilization of high-concentration allogeneic mesenchymal stem cell (MSCs) for segmental and severely comminuted osseous deficits.[14]

The dermal regeneration templates for preparation and to improve the durability of wound beds for skin grafting.

The biologic scaffolds such as urinary bladder matrix to provide for soft tissue regeneration, surgical wound bed preparation and muscle regeneration.[15]

The decelluarized allograft nerves to serve as nerve regeneration templates or conduits for segmental nerve defects in patients lacking adequate auto-graft nerve sources.

Advantages

The dermal regenerates have reduced skin erosion rates compared with those patients with skin grafting alone.

It has reduced wound healing issues surrounding the prosthetic wear sites by increasing durability.

Orthopedic union rates and nonunion rates have been reduced by adjunctive use of these measures when compared with traditional reconstructions without bony regenerates.[16]

These regenerative techniques have addressed bony healing and wound healing as well as salvage failed cases, which includes improving limb salvage rates, amputation preservation of length, and carefully selected cases.[17,18]

Even in patients with limb loss and multiple extremity amputations, using these modalities has allowed residual limbs to be preserved at a length suitable for prosthetic fitting.[19]

It may be extracted to treat lesser severe injuries from trauma, burn or oncologic cases using hybrid reconstructions.[20,21]

Disadvantages

High cost Requirement of high infrastructure Training to learn the skill.

CONCLUSION

The Hybrid Reconstruction Ladder approach shown to an effective approach for the rapid improvement and healing in a paediatric scald burn.

Conflicts of interest: None

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