Original Article

International Physiology
Volume 10 Number 3 September-December 2022
DOI: https://dx.doi.org/10.21088/ip.2347.1506.10322.1

Role of Hybrid Reconstructive Ladder in Amputated stump

Barath Kumar[1], Ravi Kumar Chittoria[2]

How to cite this article:

Barath Kumar, Ravi Kumar Chittoria/Role of Hybrid Reconstructive Ladder in Amputated stump/International Physiology.2022;10(3):83–87.

Author Affiliation: [1]Senior Resident, Department of General Surgery, [2]Professor & Registrar, Department of Plastic Surgery & Telemedicine, Jawaharlal Institute of Postgraduate Medical Education and Research Institute, Puducherry 605006, Tamilnadu.

Corresponding Author: Ravi Kumar Chittoria, Professor & Registrar, Department of Plastic Surgery & Telemedicine, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry 605006, Tamilnadu.

E-mail: drchittoria@yahoo.com

Received on: 16.08.2022

Accepted on: 05.09.2022

Abstract

Amputations are caused by the trauma, diabetic foot infection, gas gangrene. Multidisciplinary team has effectively adapted advanced reconstructive techniques merged with regenerative medicine modalities to improve outcomes non healing amputated stumps. These treatments combine traditional reconstruction measures with regenerative medicine applications and has been termed 'Hybrid reconstruction ladder'. This review article gives an overview about hybrid reconstruction ladder in management of non healing ulcer in the amputated stump.

Keywords: Amputation stump; Hybrid reconstruction ladder.

Introduction

Plastic surgery has undergone gradual evolution over time, the basic concept of methods of reconstruction is decided by complexity of the non healing ulcer of the amputated stump. 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 (Fig. 1) aids in maximizing the function while minimizing the disability and morbidity associated with traditional reconstruction.

Fig. 1: Hybrid reconstruction ladder

Materials and Methods

In this case report, 36 year old female underwent Road Traffic Accident sustained injury to both lower limb and had right below knee traumatic amputation. The patient had crush injury to right lower limb causing traumatic amputation at the level below knee joint. Now patient presented to plastic surgery department with non-healing raw area in the right amputated stump (Fig. 2-3). Autologous platelet rich plasma, Dry collagen scaffold dressing, Prolotherapy, Negative pressure wound therapy, Low level laser therapy (Fig. 4-9) was used in the preparation of wound bed and for better flap and skin graft survival. The wound healed well at the time of discharge (Fig. 10).

Results

Hybrid reconstructive ladders are an efficient way to treat wounds that are hard to heal and repair. It aids in accelerating the rate of recovery, and the patient adheres well to the regenerative therapy. When a patient's reconstructive alternatives are restricted, regenerative medicine plays a significant role in the hybrid reconstructive ladder and aids in patient rescue.

Fig. 2: Amputated stump at the time of admission.

Fig. 3: Post Amputated stump – Unhealthy Raw area

Fig. 4: Hemoglobin spray

Fig. 5: Low level laser therapy for wound healing

Fig. 6: PRFM – Platelet rich fibrin matrix applicationer

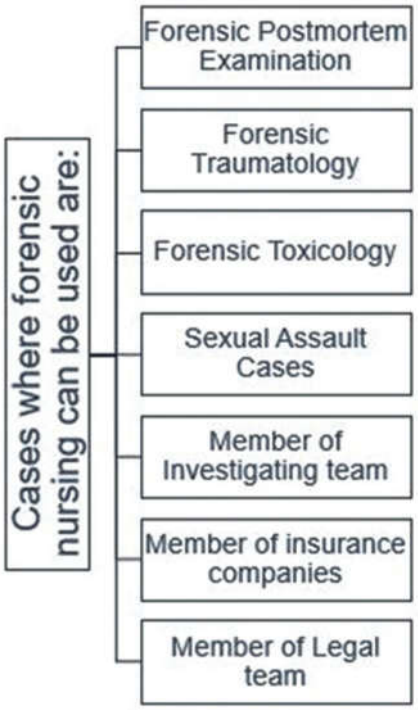
Fig. 8: NPWT dressing

Fig. 9: Egg membrane dressing

Fig. 10: Patient with splint at the time of discharge

Discussion

Plastic and reconstructive surgeons developed the phrase "Reconstructive ladder" to decide the treatment optionsfor non-healing ulcers. The simplest reconstruction strategy would be used by the surgeon to solve a clinical reconstructive issue at the bottom of the ladder, in theory. As a more intricate or effective solution was needed for a specific reconstruction challenge, the reconstructive surgeon would go up the ladder.[3-5] The hybrid reconstructive ladder that adds regenerative medicine techniques to the conventional reconstructive ladder. At each phase



of the reconstruction ladder, the results were better, and these modalities may allow for the expansion of indications for each step. Dermal regenerates, soft tissue regeneration methods, biologic scaffolds 6, fat grafting methods, and adipose-derived stem cells were all successfully used in the study's various reconstructions. As a scaffold for tissue regeneration of the wound bed for additional intervention, dry collagen was employed.[6,7] According to prolotherapy, the injection of hypertonic dextrose produces cell dehydration and osmotic rupture at the injection site, which results in local tissue injury and attracts granulocytes and macrophages. These cells then release growth factors and deposit collagen at the injection site. Dextrose concentrations as low as 5% have produced many growth factors necessary for tissue healing, according to in vitro experiments. PDGF, TGF-, EGF, b-FGF, IGF-1, and CTGF8 are a few of these growth factors. Reconstructive alternatives available to the plastic surgeon are taken into account by the reconstructive grid, a dynamic construction. It also considers elements that aid the reconstructive surgeon in selecting the best alternative to fulfil the three objectives of reconstruction form, function, and aesthetics. The borders of the reconstructive grid are determined by the criteria that assist a reconstruction specialist's judgement, such as the complexity of the wound, the surgeon's competence, the resources (and technology) at their disposal, and patient wishes.

One of the suggested techniques to enhance wound healing and scar quality is low level laser therapy (LLLT). According to literature, LLLT improves scar reformation, lowers inflammation, and increases collagen synthesis. Removal of exudates and infectious debris as well as contraction of the wound edge are part of negative pressure wound therapy (NPWT). In post-debridement wounds, NPWT has been demonstrated to be both secure and efficient.[9] As a result, NPWT was initiated, and the size of the wound was assessed at the time of dressing change. With the production of numerous growth factors and anti-inflammatory cytokines, platelets operate as regulators of inflammation, angiogenesis, cell migration, and proliferation, which is thought to aid in more rapid and effective wound healing. Growth factors found in autologous platelet rich plasma (APRP) operate intracellularly when injected or sprayed into the wound site to promote cell proliferation and wound healing. PRFM is a fibrin matrix gel comprising platelets, leucocytes, cytokines, and circulating stem cells polymerized in a tetra molecular structure. PRFM preparation is simpler, requires less handling, and does not require the use of an anticoagulant or thrombin activator. In a hospital; all of the necessary items are readily available. When opposed to the liquid formulation of APRP, the gel form of PRFM is easier to apply to the raw region. [10] After fibrin formation, the action of autologous growth factors and the biomechanical rigidity of plasmatic proteins provide a unique architecture that aids in the healing process. Growth factors from activated platelet alpha-granules, as well as others like fibrin, fibronectin, and vitronectin, play a crucial part in this process. Vessel endothelial growth factor (VEGF), fibroblast growth factor-b (FGFb), Platelet Derived Growth Factor (PDGF), hepatocyte growth factor (HGF), Epidermal Growth Factor (EGF), and angiopoietin-I are examples of these growth factors When neutrophils, macrophages, and fibroblast levels were examined under a microscope, they all increased, with PRFM treatment showing larger increases than PRP and control in all of the microscopic variables. Egg membrane is thin (60-70 µm), highly collagenized fibrous connective tissue comprised of both an inner and an outer layer. Egg membrane is comprised mainly of protein, making up 88%-96%of dry weight[6], and its unique structure provide adhesion and vapor transmission. Egg membrane is a cell membrane sheet that without a nuclear DNA. Theoretically, egg membrane has very less antigenicity.[11,12] The advantage of using boiled egg membrane is that we can harvest larger area of membrane. At the beginning of healing,

between days 0 and 5, the wounds covered with chicken egg membrane healed noticeably more quickly than the control. Hemoglobin spray comprises purified haemoglobin and is a novel approach for increasing oxygen availability in the wound bed in diabetic foot ulcer patients. Its mode of action is to bind oxygen from the atmosphere and diffuse it into the wound bed to accelerate wound healing in slow healing wounds.[13]

Conclusion

The Results were greatly improved by the use of regenerative medicine therapies in the treatment of severed stumps. The Hybrid Reconstruction Ladder is still being development and could eventually become the gold standard for managing composite tissue wounds. This must be used in a variety of situations to evaluate the hybrid reconstructive ladder for treating severed amputated stumps.

Conflicts of interest: None

Authors' contributions: All authors made contributions to the article.

Availability of data and materials: Not applicable.

Financial support and sponsorship: None.

Consent for publication: Not applicable.

References

1. Mathes SJ, Nahai F. Reconstructive Surgery: Principles, Anatomy & Technique. Vol. 2. New York: Churchill Livingstone; St. Louis: Quality Medical; 1997.
2. Gottlieb LJ, Krieger LM. From the reconstructive ladder to the reconstructive elevator. PlastReconstr Surg. 1994;93:1503– 1504.
3. Wong CJ, Niranjan N. Reconstructive stages as an alternative to the reconstructive ladder. PlastReconstr Surg. 2008;121: 362e–363e.
4. Erba P, Ogawa R, Vyas R, Orgill D. The reconstructive matrix: A new paradigm in reconstructive plastic surgery. PlastReconstr Surg. 2010;126:492–298
5. Mohapatra, Devi Prasad M.Ch.; Thiruvoth, FrijiMeethale M.Ch. Reconstruction 2.0: Restructuring the Reconstructive Ladder, Plastic and Reconstructive Surgery: March 2021–Volume 147–Issue 3–p 572e-573e.
6. Vedder NB. Wei FC, Mardini S, eds. Problem analysis in reconstructive surgery: Reconstructive ladders, elevators, and surgical judgment. In: Flaps and Reconstructive Surgery. 2017:2nd ed. Toronto: Elsevier; 1–5.
7. Turner NJ, Badylak SF. Biologic scaffolds for musculotendinous tissue repair. Eur. Cell Mater. 25, 130–143 (2013).
8. Tenenhaus M, Rennekampff HO. Surgical advances in burn and reconstructive plastic surgery: new and emerging technologies. Clin. Plast. Surg. 39(4), 435–443 (2012).
9. Saurabgupta et al. Effect of Low Level Laser Therapy (Lllt) On The Severity Of Post-Burn Immature Scars: A Randomized Control Study. International Journal of Clinical And Diagnostic Research Volume 8, Issue 1, Jan-Feb 2020.
10. Anitua E, Pino A, Orive G. Opening new horizons in regenerative dermatology using platelet-based autologous therapies. Int J Dermatol, 2017;56:247–251.
11. Maeda K, Sasaki Y. An experience of hen-egg membraneas a biological dressing. Burns 1981;8:313- 6.
12. Leach RM. Biochemistry of the organic matrix of theeggshell. Poult Sci 1982;61:2040-7.
13. Bateman SD. Topical haemoglobin spray for diabetic foot ulceration. Br J Nurs. 2015;24:S24–9.