

Role of Hybrid Reconstruction Ladder in Osteomyelitis

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Abstract

The development of chronic osteomyelitis is most common in lower extremity post traumatic due to road traffic accidents. A multidisciplinary team has successfully adopted advanced reconstructive methods combined with orthopaedic and plastic interventions to enhance the results of chronic osteomyelitis. These procedures, known as "Hybrid reconstruction ladder", combine conventional reconstruction techniques with regenerative medicine applications. This study highlights the application of hybrid reconstruction ladder for treatment of osteomyelitis.

Keywords: Osteomyelitis; Hybrid; Reconstruction ladder.

INTRODUCTION

The fundamental idea of reconstructive techniques being prioritised by complexity has been kept and spread in many ways as plastic surgery has slowly evolved over time. The majority of descriptions begin with secondary intention

closure, then move on to direct closure, local flaps, and remote flaps. Finer differences between local, regional, and free flaps, as well as inserting tissue ingrowth by regenerative methods along the spectrum, have been made by a number of authors.^{1,2} The complicated wound pattern has spurred efforts to develop novel and groundbreaking tissue regeneration methods. To improve results, a multidisciplinary team has successfully adopted modern reconstructive procedures combined with regenerative medicine modalities. These procedures are referred to as "hybrid reconstructions" because they mix conventional reconstructing techniques with regenerative medicine applications. The hybrid reconstruction model (Fig. 1) aids in maximizing the function while minimizing the disability and morbidity associated with traditional reconstruction. The objective of this study was to evaluate the efficacy of hybrid reconstruction ladder for the treatment of chronic osteomyelitis.

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Fig. 1: Hybrid reconstruction ladder

MATERIALS AND METHODS

This study was conducted in the department of plastic surgery in a tertiary care centre in South India. Departmental ethical clearance and consent from the subject were obtained. In this study, we are assessing the role of hybrid reconstruction ladder in a 30 year old patient with no comorbidities presented with alleged history of road traffic accident sustained left open type 3C (Gustilo Anderson classification) proximal tibial fracture with popliteal artery injury. He underwent knee spanning external fixator application with popliteal

artery exploration and repair. Wound debridement with skin grafting done for the lower limb raw area. On examination patient had unhealthy wound over the left knee (Fig. 2). The wound size was measured with digital planimetry (Fig. 3). The plan was to apply hybrid reconstruction ladder and hence patient under went hydrojet debridement, Low level laser therapy, Autologous platelet rich plasma, Vitamin D and collagen granules, Dry collagen scaffold dressing, Negative pressure wound therapy (Fig. 4-8) followed by local perforator keystone flap based on the perforator on the lateral side of the ulcer (Type 2B) (Fig. 9).



Fig. 2: Wound over the left knee region with unhealthy granulation tissue.



Fig. 3: Digital planimetry of the wound



Fig. 4: Application of Low-level laser therapy



Fig. 5: Application of Autologous platelet rich plasma (APRP)



Fig. 6: Application of Collagen granules and Vit D granules



Fig. 7: Application of Bilayered collagen scaffold therapy



Fig. 8: Application of NPWT therapy



Fig. 9: Type 2B keystone flap

RESULTS

Postoperative period was uneventful. No complications were noted. The flap was healthy and healed well at discharge (Fig. 10). The graft uptake was good. The patient discharged without any complications.



Fig. 10: Healed wound at the time of discharge

DISCUSSION

The lower extremity is the most common site for chronic osteomyelitis resulting from trauma. Chronic osteomyelitis is a serious complication of open fracture and also may arise because of internal fixation of a closed fracture. Treatment of chronic osteomyelitis requires aggressive surgical debridement to remove the sequestrum and infected tissue, which may result in the formation of dead space. Dead space is recognized as one of the causes of repeated episodes of infection. Therefore, the management of dead space is the key point in the treatment process. Various treatment options including local flaps, free flaps, muscle flaps, non-vascularized bone, vascularized bone grafts, and antibiotic-loaded polymethylmethacrylate have been suggested. 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 our study, the patient is a known case of left knee region unhealthy wound with osteomyelitis. The patient underwent application of hybrid reconstruction ladder including regenerative therapies followed by local type 2B keystone flap cover based on local perforator. A hybrid reconstructive ladder that augments the traditional reconstructive ladder with regenerative medicine modalities helps in improving unhealthy wound for better flap survival. 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. In various studies it has been reported use of dermal regenerates, soft tissue regeneration techniques, biologic scaffolds⁶, fat grafting techniques and adipose-derived stem cells in a number of reconstructions. Dry collagen is one of the regenerative technology commonly 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 In our study also we used NPWT. 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. 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.¹⁰

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 further mobilization 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.¹⁰ We have used the type IIB keystone flap for the wound 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 keystone flap (Type 2B) easy to design and owing to the surrounding skin laxity the donor site. As in literature, our study also found hybrid reconstruction principle useful in the armamentarium of reconstruction.

CONCLUSION

Hybrid Reconstruction Ladder is continuing to evolve and may become the standard of care for effective management of composite tissue wounds with osteomyelitis and chronic non healing ulcers.

Conflicts of interest: None

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