

Role of Hemoglobin Spray in Management of Amputation Stump

Nishad K.¹, Neljo Thomas², Ravi Kumar Chittoria³, Barath Kumar Singh⁴,
Jacob Antony Chakiath⁵

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Abstract

Wound healing is complex process and has overlapping steps of haemostasis, the inflammatory and proliferative phases, remodelling. Problem with the edge of the wound can be detrimental to healing and can cause delay in wound healing. In this article, we share experience of using topical haemoglobin (Hb) spray for wound bed preparation in non-healing ulcer overlying the amputation stump.

Keywords: hemoglobin spray; amputation stump.

INTRODUCTION

Wound bed preparation is a new concept and is done with the T.I.M.E method. The Edge is a component which involves granulation tissue for better healing. Wound bed preparation is needed in difficult to heal wounds. Cost friendly methods in place of commercially available resources are essential in our population which will widen the acceptance of plastic surgery in the society. In this study we have used the patient's own blood for

preparation of hemoglobin spray with materials easily available in the hospital.

MATERIALS AND METHODS:

This study was conducted in the department of Plastic Surgery at tertiary care center after obtaining the departmental ethical committee approval. Informed written consent was taken from patient in study. The details of the patient are as follows: 37 year old female with no co morbidities presented with history of road traffic accident 4 months back and underwent right below knee amputation due to vascular injury and degloving injury of the left lower limb and was treated with serial debridement in cardiothoracic and general surgery department. Now, the patient came to plastic surgery department with extensive raw area over left lower limb and non-healing ulcer over right below knee amputation stump. The dressings and antibiotic changes failed to bring healing of the wound. Wound bed preparation was planned for the patient with Hemoglobin spray harvested from the patient blood as her ulcer did not show

Author Affiliation: ^{1,2,4,5}Senior Resident, ³Professor, Department of Plastic Surgery, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry 605006, India.

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

E-mail: drchittoria@yahoo.com

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any evidence of healing and was infected (Fig. 1). Under all aseptic precautions, 2.7ml of blood was harvested from ante-cubital vein. It was mixed with 0.3ml of 3.8% sodium citrate solution (Na-citrate to blood ratio=1:9) to prevent coagulation. The blood was sprayed uniformly on wound spraying mechanism and sterile dressing was applied (Fig. 2). The spray was given twice a week for 2 weeks. The wound was assessed after 2 weeks. Although the cost of commercially available Hemoglobin spray is 12000 INR, we used the patient's own blood and also materials easily found in the hospital setup.



Fig. 1: Wound over the amputation stump



Fig. 2: Topical haemoglobin therapy given to the amputation stump

DISCUSSION

Wound bed preparation was called as 'the global management of the wound to accelerate endogenous healing or to facilitate the effectiveness of other



Fig. 3: Healing wound bed

therapeutic measures. Wound bed preparation can be summarized by the acronym T.I.M.E with T for tissue: non-viable or deficient. I for infection/inflammation, M for moisture balance. E for epidermis which was later changed to E for edge. Wound debridement, control of inflammation/infection and moisture are essential components of wound bed preparation that may produce the edge of the wound to get activated, but if they fail, advanced therapies may be required.

Oxygen is an important component in the wound healing¹ process and when in hypoxia, wounds do not heal. There is an increased demand for oxygen in the healing phase of damaged tissue, enabling wound healing to progress. Local oxygen delivery is important in wound healing, and it is recognized that decreased oxygenation can lead to a chronic non-healing ulcer.² Fibroblast replication, collagen deposition, angiogenesis, resistance to infection, and intracellular leukocyte bacterial killing are all oxygen dependent responses essential to normal wound healing.^{3,4} Studies suggests that intermittent oxygenation of wound bed causes events that augment wound healing. Increased tissue oxygen level leads to increased reactive oxygen as well as nitrogen. This leads to further neovascularization by increased level of VEGF, TGF-beta, angiopoietin etc. There is increased ECM formation due to elevated FGF expression and increased collagen synthesis. It also reduces inflammation by

decreasing edema, proinflammatory cytokines etc.⁵ The approach to facilitate oxygen diffusion by a transporter molecule like hemoglobin led to the possibility of a constant supply of oxygen to the wound bed after topical application of the hemoglobin spray to the wound. Therefore, the use of hemoglobin to facilitate oxygen diffusion seems to be an ideal way to increase the oxygen supply to the wound bed and, as a result, enhancing the underlying wound healing processes.

In this end, Barnikol *et al*⁷ exploits the principle of hemoglobin mediated facilitated oxygen diffusion in aqueous solutions by applying hemoglobin to the wound bed as an aqueous solution. In addition to the free diffusion of oxygen, which is limited by the fluid barrier, the addition of hemoglobin possibly results in improved facilitated diffusion.⁸ Carrier molecules that are well suited for this include mammalian hemoglobin, that are water soluble and are capable of transporting oxygen outside of red blood cells.⁷⁻⁹

Granulox TM is a commercially available product from In First Ltd, UK, which is designed to be able to deliver oxygen to tissue.¹⁰ The product, Granulox TM contains porcine hemoglobin in a spray canister. When Granulox TM sprayed, hemoglobin binds to atmospheric oxygen. Once saturated with oxygen, the hemoglobin becomes oxyhemoglobin (HbO₂), which diffuses to the base of the wound, and increases the oxygen supply to the cells by diffusion. There are no adverse effects of using topical hemoglobin spray even after extensive studies and has been found tolerable for use.¹¹ It is applied twice weekly to wound during dressing, and can be used in a clinic or patient's home setting.

Limitations: The study was done on a single patient and needs large population based study to apply in practice.

Conclusion: Topical hemoglobin spray was found to be useful in management of non-healing ulcer as it improved the granulation tissue. Long-term clinical observations are needed to determine whether topical insulin can be used for wound bed preparation.

Limitations: This was done on a single patient and needs large population based study to apply the finding in clinical practice.

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REFERENCES

1. Hunt TK, Zederfeldt B, Goldstick TK. Oxygen and healing. *Am J Surg.* 1969;118:521-5.
2. Winfeld B. Topical oxygen and hyperbaric oxygen therapy use and healing rates in diabetic foot ulcers.
3. Woo K, Ayello EA, Sibbald RG. The edge effect: current therapeutic options to advance the wound edge. *Adv Skin Wound Care.* 2007;20:99-117.
4. Hopf H.W., Gibson J.J., Angeles A.P. Hyperoxia and angiogenesis. *Wound Rep Regen.* 2005; 13(6):558-564.
5. Lam, G., Fontaine, R., Ross, F. L., & Chiu, E. S. (2017). Hyperbaric Oxygen Therapy. *Advances in Skin & Wound Care*, 30(4), 181-190.
6. Thom SR. Hyperbaric oxygen: its mechanisms and efficacy. *Plast Reconstr Surg.* 2011;127 Suppl 1(Suppl 1):131S-141S.
7. Barnikol WKR, Teslenko A, Pötzschke H (2005) Eineneuetopische Behandlung chronischer Wunden mit Hämoglobin und Sauerstoff: Verfahren und erste Ergebnisse. *ZfW* 10(3):98-108.
8. Wittenberg JB (1966) The molecular mechanism of hemoglobin-facilitated oxygen diffusion. *J Biol Chem* 241(1):104-114.
9. Scholander PF (1960) Oxygen transport through hemoglobin solutions. *Science* 131:585-590.
10. Oxygen wound therapy: The clinical and cost impact of using topical hemoglobin spray (Granulox%). London: Wounds UK, 2017.
11. Arenberger, Peter & Engels, Peter & Arenbergerova, Monika & Gkalpakiotis, Spyridon & Martínez, Francisco & Anaya, Americo & Fernandez, Laura. (2011). Clinical results of the application of a hemoglobin spray to promote healing of chronic wounds. *GMS Kranken hausygieneinter disziplinär.* 6. Doc05. 10.3205/dgkh000162.

