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Role of Cyclic Negative Pressure wound Therapy in the Management of Thermal Burns

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Abstract

Burns are one of the leading cause of morbidity and death in children. Every physician and surgeon should always have a basic knowledge about the care of thermally injured child. Burn injury is a chronic disease requiring long term treatment and supervised rehabilitation, reconstructive surgery and psychosocial support.

Keywords: Thermal injury; Cyclic Negative Pressure; Wound Therapy.

INTRODUCTION

Since the introduction of the cyclicnegative pressure wound therapy (NPWT) system by Morykwas and Argenta, it has been applied to a number of wounds and has become an influential and effective technique for healing simple and complex wounds. The conventional cyclic NPWT system adopts either 'intermittent' or 'continuous' mode.

While the continuous mode constantly applies a sub-atmospheric pressure of 125 mmHg, the intermittent mode creates a sub-atmospheric pressure of 125 mmHg for 5 minutes and a 2 minutes resting phase of 0 mmHg.

In experiments performed on animal models, the intermittent mode showed increased perfusion level and formation of granulation tissue in the wound area compared with the continuous mode.[1,2] Despite the effectiveness of intermittent mode in wound healing, it has been avoided in clinical application because of the pain occurring every few minutes during the initiation phase of the system to reach 125 mmHg. [3–6]

The cyclic NPWT system is similar to the intermittent mode in terms of using the same maximal sub atmospheric pressure, but the pressure never reaches zero in the cyclic mode. So, it continuously creates certain pressure gradient that oscillates between 125 mmHg and the preset sub atmospheric pressure. The cycle runs based on the changes in sub atmospheric pressure, not time, and thus its frequency reflects the wound volume. In this article we present a case of a one year old male child who presented with second degree superficial burns over the chest, abdomen and right upper limb and the use of cyclic NPWT.

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MATERIAL AND METHODS

This study was conducted in the Department of Plastic Surgery in a tertiary care institute. Informed consent was obtained from the patient under study. Department scientific committee approval was obtained. It is a single center, non-randomized, non-controlled study. The patient under study was a 1 year old male child, with no other known comorbidities. Patient was analyzed systematically and was found to have second degree superficial burns to his chest, abdomen and right upper limb. Wound bed was prepared in accordance with TIME concept mentioned in the guidelines, the ulcer was serially assessed and documented according to bates – Jensen wound assessment tool. Non-viable necrotic tissue was managed with multiple sessions of surgical & hydro debridement. Infection was managed with local antimicrobials & antibiotics according to culture sensitivity. As wound was wet in nature, moisture control was done using cyclic negative pressure wound therapy. Cyclic negative wound pressure therapy sittings was applied twice. (Fig. 1)

Fig. 1: Superficial burns at presentation.

RESULTS

Wound bed gradually improved, clinical decision was taken to reconstruct with skin grafting. (Fig. 2).

Fig. 2: Cyclic negative pressure wound therapy applied on wound.

Fig. 3: Wound underwent skin grafting following wound bed preparation after cyclic negative pressure wound therapy

DISCUSSION

The cyclic mode operates its negative pressure in a manner similar to the sine wave by cycling through the designated negative pressures. Once it hits the upper target pressure of 125 mmHg, the pressure system shuts off and the pressure slowly drops till the lower target pressure is reached, regardless of time. As the change in the intralesional pressure is measured, the drop velocity of the pressure is closely associated with the defect volume in the cyclic mode. In other words, the larger the volume of defect, the shorter the time taken for completing one cycle of the system.

Improved tensile strength in in vivo research has previously showed increased collagen I production in wound healing. This rise could be owing to the pro-angiogenic effect of increased vascular endothelial growth factor and fibroblast growth factor levels. Both growth factors are involved in the wound healing process, namely in the stages of hemostasis, proliferation, and repair, and so influence wound healing. VEGF also controls cell proliferation, differentiation, and migration during angiogenesis. This encourages the creation of new capillaries, allowing for better circulation to the wound site and hence the delivery of critical nutrients and oxygen. The increased expression of certain mediators, such as IL-1 and monocyte Chemo attractant Protein-1, causes VEGF to be stimulated (MCP-1).[3]

Human and animal's studies have shown increased growth of granulation tissue, increased blood flow, diminution of the wound area, and regulation of inflammatory response with VAC therapy.[7] VAC causes wound contraction, stabilization of the wound environment, decreased edema with removal of wound exudates, and micro deformation of cells. These effects allow VAC to accelerate wound healing by virtue of increase blood flow; reduced bacterial load; and improved wound bed preparation for subsequent coverage. The compression of tissue by negative pressure causes tissue hypoxia due to decreases perfusion beneath the foam which stimulates angio-neogenesis, and local vasodilatation due to release of nitric oxide.[8,9,10]

Micro deformation/micro strain of cells due to VAC causes tissue expansion effect with release of growth factors. This tissue expansion effect is due to the differential pressure in the tissues after negative pressure application. The pressure within the cells is positive; while the pressure outside the cells and beneath the dressing is negative. This may lead to expansion of cells, growth of granulation tissue and pulling of wound edges closer to one another reducing wound size.

CONCLUSION

Cyclic application of "negative pressure" results in a superior local enhancement of cutaneous microcirculation with regards to blood flow and consecutive tissue oxygenation. Beyond that, repeated alterations between different levels of "negative pressure" due to cyclic application represent a greater stimulus for remote conditioning effects, indicating a superior local interaction with the underlying tissue. Hence we were able to manage superficial burns using cyclic NPWT successfully however it needs large scale randomized trials for application in clinical practice.

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