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Role of Cyclic Negative Pressure Wond Therapy in Scalp Electrical Burns

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Abstract

Over the past two decades, the application of "negative pressure" has evolved to a cornerstone in the treatment of acute and chronic wounds in almost all specialties. Continuous, Intermittent, cyclic are the three types of Negative pressure Wound Therapy (NPWT). 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. Cyclic application of "negative pressure" results in a superior local enhancement of cutaneous microcirculation with regards to blood flow and consecutive tissue oxygenation. This articlehighlightsrole of role of cyclic negative pressure wound therapy in scalp burns wound.

Keywords: Cyclical; Negative pressure wound therapy; Scalp; Electrical; Burn; Wound.

Introduction

Negative pressure wound therapy (NPWT) system was introduced 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 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-minute resting phase of 0 mmHg.[1] 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.[2] So, it continuously creates certain pressure gradient that oscillates between 125 mmHg and the pre-set sub atmospheric pressure. The cycle runs based on the changes in sub atmospheric pressure, not time. This article highlights role of role of cyclic negative pressure wound therapy in scalp burns wound.

Materials and Methods

This study was done at tertiary care hospital after obtaining approval of departmental scientific and ethical committee. Informed consent was obtained from the patient.This is a prospective, descriptive,non randomised case study about a 45 year old male who sustained electrical burn injury by 220 volts alternating current to the vertex region of the scalp (entry zone) and the left leg (exit zone). The patient was disoriented and unconscious at the time of admission with a Glasgow score of 12 and was intubated. Multiple second degree superficial burns were present over the face, neck, chest andanterior aspect of abdomen, bilateral arms, bilateral thighs and second degree deep burns involving frontoparietal region of scalp at the vertex (Fig. 1). CT skull showed small ill defined hypodense area with loss of grey white differentiation noted in the left frontal region suggestive of left frontal infarct. He was resuscitated with the standard WHO burn protocol. Serum electrolytes, urea and creatinine, urine analysis, and electrocardiogram were normal, urine myoglobin negative. Patient was asymptomatic with no seizures, syncope, focal neurological deficits. He was managed conservatively with prophylactic antiepileptic Phenytoin. The patient was extubated after three days of intensive care. According to the manual muscle test, both upper and lower extremities were normal. Sensory function was intact, muscle stretch reflexes were normoactive, no pathological reflexes were identified, and all the other cranial nerve and cerebellar functions were normal. Debridementof scalp wound was done after demarcation of necrotic patch. Non-viable necrotic tissue was debrided without damaging the normal tissues in both horizontal and vertical planes with dermabrader till the appearance of bleeding points (Fig. 2). After debridement, regenerative therapy with cyclical negative pressure wound therapy was done to enhance granulation over the scalp bone (Fig. 3). As the wound bed showed healthy granulation (Fig. 4), perforator based type 4 Keystone flap was raised from the scalp and sutured over the well granulated scalp wound to the edges of the defect (Fig. 5). Cyclical negative pressure applied post-operatively over the keystone flap and skin grafted site of the scalp (Fig. 6). aterials and Methods

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Results

There was healthy granulation of the wound pre-operatively and good take of perforator based Keystone flap without necrosis. No complications were noted. Post-operative day 7, there was no necrosis in the flap and flap was healthy with good take (Fig. 7). The skin grafted site also shows good take of graft without loss. The Cyclical negative pressure wound therapy was helpful in granulation of wound, healthy flap survival by preventing flap necrosis and good skin graft take.

Fig. 1: Scalp electrical burn wound at admission

Fig. 2: Post dermabrasion assisted debridement till the appearance of bleeding points

Fig. 3: Cyclical negative pressure wound therapy to scalp burns wound

Fig. 4: Well granulated electrical burn scalp wound

Fig. 5: Type 4 keystone perforator flap with skin graft to the secondary defect

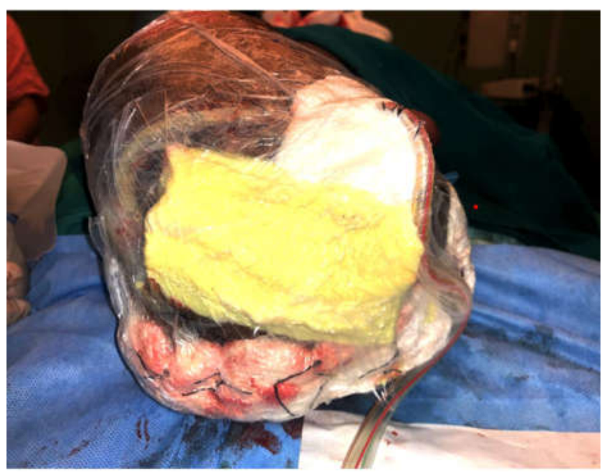

Fig. 6: Cyclical negative pressure wound therapy postoperatively

Fig. 7: Post-operative day 7 Keystone perforator flap

Discussion

"Negative pressure" has become a cornerstone in practically all specialities for treating acute and chronic wounds. Various synonyms represent past developments and contemporary implementations of the procedure, including "Vacuum assisted closure" (VAC), "Negative Pressure Wound Therapy" (NPWT), "closed incision Negative Pressure Therapy" (ciNPT), or "NPWT with instillation" (NPWTi).[3] All but ciNPT are used to treat open wounds and impose the known benefits of "negative pressure" therapy on wound healing, i.e., temporary wound closure, promotion of wound bed granulation, mechanical contraction and stabilisation of wound edges, and effective bacterial load reduction. Wound bed perfusion aids healing. "Negative pressure" affects wound bed perfusion. Diverging research results could call into question the idea that a negative pressure dressing improves local and neighbouring wound bed perfusion.[4,5] Physically driven comprehension of compression of underlying tissues by a negative pressure dressing, especially on the surface pressured capillary network, raised scepticism. Micro vessel obstruction would reduce capillary blood flow, causing hypoxia and likely ischemia. Laser doppler velocimetry, a widely used technology for perfusion analysis, was questioned due to pressure artifacts,[6] resulting in a false positive sign of an increase in perfusion under an applied NPWT patch. In animal models, intermittent mode increased perfusion and granulation tissue production compared to continuous mode. Despite intermittent mode's efficiency in wound healing, it's avoided in clinical applications due to pain during the system's initiation phase to reach 125 mmHg. Thus, 'cyclic' mode reduces pain while maintaining intermittent mode's efficacy.

Current research on perfusion modifications owing to ciNPT and negative pressure wound therapy over closed incisions indicated that treatment enhanced blood flow and tissue oxygenation.[7-9] NPWT was also successful in free tissue transfer, reducing postoperative tissue damage.[10] Negative pressure wound therapy had no side effects. In a study, we used continuous laser-doppler flowmetry and white light spectroscopy to analyse microcirculatory alterations under an NPWT dressing. Intermittent negative pressure increases tissue perfusion and oxygen saturation.

NPWT Types

1. Continuous NPWT - the continuous mode consistently administers 125 mmHg.
2. Intermittent NPWT - the intermittent mode creates 125 mmHg for 5 minutes and 0 mmHg for 2 minutes.
3. Cyclic NPWT uses the same peak subatmospheric pressure as intermittent mode, but the pressure never approaches zero. So, it provides a constant pressure differential between 125 mmHg and sub atmospheric pressure.

Suction and cutaneous blood flow below the foam dressing were considerably increased in all three types, regardless of pressure level.[11] As expected, pain/discomfort was minimal.

CyclicNPWT is less painful and has superior local and regional cutaneous perfusion.

Cyclic NPWT Disadvantage

1. Sub atmospheric pressure requires expanding devices.
2. Classic suction devices make cyclic NPWT difficult.

In this preclinical study on acute alterations of cutaneous microcirculation under NPWT dressing, we noticed an increase in local perfusion dynamics and tissue oxygen saturation.

All three application regimes, continuous, intermittent, and cyclic, increased microcirculation to varying degrees. Comparing different application modes, cyclic had better local and remote cutaneous perfusion.[12] Continuous therapy is the standard of care despite early evidence that intermittent NPWT is superior for granulation tissue development and angiogenesis. Probably because intermittent "negative pressure" activation, which generates frequent spikes in wound surface pressure, is unpleasant."Cyclic mode" looks to be a potential compromise for patient satisfaction and wound care.[13] Cyclic NPWT caused little pain.Resting capillary pressure in human cutaneous microcirculation is 10.5 to 22.5 mmHg or 41.0 mmHg.[14,15] Thus, an NPWT dressing with surface pressure 30.0 mmHg could occlude cutaneous capillaries. Given that capillary pressure increases in response to increasing venous pressure, a sub-total blockage of dermal microvasculature can be anticipated.[16] Vasodilation and improved local flow are complex mechanisms of cutaneous vascular response to stimuli.[17] Repeated subtotal capillary occlusion stimulates tissue. Post-occlusive reactive hyperaemia (PORHA) and enhanced mechano-humoral transduction to the vascular bed modify intravascular shear stress and may account for greater results in the intermittent and cyclic groups. [18,19] Pressure duration, number of cycles, and body site are critical variables for improving distant microcirculation. An ideal NPWT dressing must respect each patient's comorbidities, wound location, and tissue composition.[20-22] In our cyclic NPWT was used preoperatively to prepare the wound bed and also postoperatively for good flap and skin graft take.

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. Patient compliance is also improved in addition to reduced morbidity.

Conflicts of interest: None

Authors’ contributions: All authors made contributions to the research, is putatively expected to be useful article.

Availability of data and materials: Not applicable.

Financial support and sponsorship: None.

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