Original Article

RFP Journal of Biochemistry and Biophysics
Volume 7 Number 2, July - December 2022
DOI: http://dx.doi.org/10.21088/rfpjbb.2582-3558.7222.1

Role of Cyclical Negative Pressure Wound Therapy in Wound Bed Preparation in Necrotizing Fascitis

Shivanand Hosamani[1], Ravi Kumar Chittoria[2], Barath Kumar Singh. P[3]

How to cite this article:

Shivanand Hosamani, Ravi Kumar Chittoria, Barath Kumar Singh. P/Role of Cyclical Negative Pressure Wound Therapy in Wound Bed Preparation in Necrotizing Fascitis/JBB Journal of Biochemistry and Biophysics. 2022;7(2):45–48.

Abstract

Necrotizing fasciitis is an infection of subcutaneous tissue and fascia which may spread rapidly to deeper tissue and surrounding tissue which may cause damage to the tissue and present as a localized infection and fulminant septic shock with high mortality rate. Negative pressure wound therapy (NPWT) has been used to treat wounds in numerous different anatomical locations, with different levels of complexity and varying pathologies. NPWT has been found to be effective in wound bed preparation but cyclical negative pressure wound therapy (cNPWT) has not been reported in literature. This study highlights our experience in wound bed preparation using cNPWTin a case on necrotizing fasciitis.

Keywords: Cyclical Negative pressure wound therapy (cNPWT); Wound bed preparation; Necrotizing fasciitis.

INTRODUCTION

Necrotizing soft tissue infections (NSTIs) include necrotizing forms of fasciitis, myositis, and cellulitis. These infections are characterized clinically by fulminant tissue destruction, systemic signs of toxicity, and high mortality.[1,2] Accurate diagnosis and appropriate treatment must include early surgical intervention and antibiotic therapy. Several different names have been used to describe the various forms of necrotizing infections; this is related in part to naming based on clinical features rather than surgical or pathologic findings. The degree of suspicion should be high since the clinical presentation is variable and prompt intervention is critical. The lay press has referred to organisms that cause NSTI as flesh eating bacteria.[3] There is sufficient evidence to conclude that healing of necrotizing fasciitis is accelerated by NPWT. Though it is well established therapy in the armamentarium of wound management, its role in wound bed preparation before cover by skin graft

Author's Affiliation: [1]Junior Resident, [3]Senior Resident, Department of Plastic Surgery, [2]Professor & Head of IT Wing and Telemedicine, Department of Plastic Surgery & Telemedicine, Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry 605006, India.

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

E-mail: drchittoria@yahoo.com

Received: 21.11.2022 **Accepted:** 03.12.2022

or flap has not been studied well. NPWT has been found to be effective in wound bed preparation but cyclical negative pressure wound therapy (cNPWT) has not been reported in literature. This study highlights our experience in wound bed preparation using cyclical NPWT in a case on necrotizing fasciitis.

MATERIALS ANDMETHODS

This study was conducted in the department of plastic surgery in a tertiary care center after obtaining the departmental ethical committee approval. Informed written consent was taken from the patient. The study is a prospective observational type done on a 60-year-old male with known co-morbidities including hypertension & coronary artery disease with ejection fraction of 25%. Patient presented with raw area (Fig. 1) over left lower limb & perineum of one month duration. He was apparently well one month back when he developed multiple blebs over left lower limb & perineum which ruptured leaving raw area with rapid progression of wound infection with foul smelling discharge. He was diagnosed with clinically as a case of necrotizing fasciitis. He underwent multiple debridement in referral surgery department after that he was referred to department of plastic surgery for further wound care. Further multiple wound debridement was done followed by cyclic negative pressure wound therapy was applied for wound bed preparation (Fig. 2). Till wound bed got ready cadaveric human skin (allograft) was used as biological dressing. Wound bed was reassessed every weekly till wound bed got ready for cover by skin graft or flap.

Fig. 1: At admission with extensive necrotizing fasciitis of left lower limb & perineum.

Fig. 2: Application of cNPWT

RESULTS

After 2 weeks, the wound bed got ready with appearance of healthy granulation tissue (Fig. 3). The future plan is to cover the raw area with skin grafting once patient becomes fit for anesthesia.

Fig. 3: Wound bed with healthy granulation tissue with allograft in position

DISCUSSION

Necrotizing fasciitis is a life-threatening condition, with a high mortality rate (median mortality 32.2%) that approaches 100% without treatment. Numerous conditions are associated with this pathology, such as diabetes mellitus, immunosuppression, chronic alcohol disease, chronic renal failure, and liver cirrhosis, which can be conductive to the rapid spread of necrosis, and increase in the mortality rate. The diagnosis of NF is difficult and the differential diagnosis between NF and other necrotizing soft tissue infections. The delay in diagnosis can be fatal, and septic shock is inevitable if the disease remains untreated. The characteristic of NF is the clinical status change over time. The early clinical picture includes erythema, swelling, tenderness to palpation, and local warmth; once the infection develops, the infection site presents skin ischemia with blisters and bullae. The diagnosis of NF can be secured faster with the use of laboratory based scoring systems, such as the LRINEC score or the FGSI score, especially in cases of Fournier's gangrene. However, the diagnosis is definitely established by performing explorative surgery at the infected site.[4]

Management of the infection begins with antibiotic treatment. In the majority of cases with NF (70–90%) the reasonable pathogens are two or more, suggesting the use of broad spectrum antibiotics. The value of antibiotic treatment in

NF is relatively low, and early and aggressive drainage and debridement is required. In NF of the extremities, the clinician should consider amputating the infected limb, although this will not reduce the risk of mortality. Finally, postoperative management of the surgical wound is important, along with proper nutrition of the patient.[5]

The introduction of the negative pressure wound therapy (NPWT) system by Moryk was 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.[6] 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. [7] 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.[8] 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. Thus, 'cyclic' mode would minimize the pain while maintaining the superior efficacy of the intermittent mode. 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.Within this preclinical study on acute changes of cutaneous microcirculation under an applied NPWT dressing, we observed a significant increase of local perfusion dynamics with consecutive improvement of tissue oxygen saturation.[9]

Interestingly, all three compared modes of application, continuous, intermittent, and cyclic, resulted in locally enhanced microcirculation of a greater or lesser extent. In the comparison of different application modes, we observed superior effects on local and remote cutaneous perfusion in the cyclic group.[10] The continuous mode represented the most common setting in clinical wound care according to a published meta-analysis of Suissa et al. in 2011, in which discontinuous applications were rarely reported. Notably, continuous treatment represents the generally accepted standard of care despite already available early evidence of superior capabilities of an intermittent NPWT treatment with respect to formation of granulation tissue or angiogenesis. Most likely, this is attributable to the fact that intermittent activation of "negative pressure," which causes repeated spikes in surface pressure to the wound, is believed to be unpleasing. Lately, the introduction of the "cyclic mode" appears as a promising compromise combining both the satisfaction of patients and superior wound treatment. Pain levels were generally low in cyclic NPWT.[11]

In human cutaneous microcirculation, resting capillary pressure was reported in a range from 10.5 to 22.5 mmHg or even 41.0 mmHg. Thus, applied surface pressure of 30.0 mmHg via a NPWT dressing could potentially result in an occlusion of cutaneous capillaries. Given the finding that capillary pressure also increases in response to a higher venous pressure, at least a sub-total occlusion of the dermal microvasculature due to the intervention can be assumed.[16] Overall, the mechanisms of cutaneous vascular response to certain stimuli are complex, especially concerning vasodilation and improvement of local flow.[12] Repeated capillary (subtotal) occlusion represents a strong stimulus for the affected tissue. Both post-occlusive reactive hyperemia (PORHA) and increased mechano-humoral transduction to the vascular bed result in alterations of intravascular shear stress and could be accountable for superior effects in the intermittent and, particularly, in the cyclic group. We also assessed changes of cutaneous microcirculation on the contralateral thigh and found stronger effects in the cyclic group. Previous studies on Remote Ischemic Conditioning (RIC), showed alterations in the applied stimulus can influence the triggered improvement of cutaneous perfusion.[13] Duration of applied pressure, number of repeated cycles, and body site are important variables to optimize the conditioning effect on the improvement of remote microcirculation. An ideal application of a NPWT dressing must respect the individual circumstances of each patient and treated wounds with respect to comorbidities, location of the wound, and tissue composition. In our study cyclical negative pressure wound therapy plays an effective role as an adjuvant in the wound bed preparation in necrotizing fasciitis.

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. Further research is warranted to investigate the correlation between local perfusion enhancements and granulation tissue formation due to cyclic NPWT in humans.

REFERENCES

1. Stevens DL, Bryant AE. Necrotizing Soft-Tissue Infections. N Engl J Med 2017; 377:2253.
2. Stevens DL, Bisno AL, Chambers HF, et al. Practice guidelines for the diagnosis and management of skin and soft tissue infections: 2014 update by the infectious diseases' society of America. Clin Infect Dis 2014; 59:147.
3. Bonne SL, Kadri SS. Evaluation and Management of Necrotizing Soft Tissue Infections. Infect Dis Clin North Am 2017; 31:497.
4. Camille Hua, Tomas Urbina, RomainBosc, et al. Necrotising soft-tissue infections. Lancet Infect Dis 2022.
5. Jahnson L, Berggren L, Björsell-Ostling E, et al. Streptococcal myositis. Scand J Infect Dis 1992; 24:661.
6. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. Ann PlastSurg 1997;38:563–76.
7. Morykwas MJ, Argenta LC, Shelton-Brown EI, McGuirt W. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. Ann PlastSurg 1997;38:553–62.
8. Glass GE, Nanchahal J. The methodology of negative pressure wound therapy: separating fact from fiction. J PlastReconstrAesthet Surg. (2012) 65:989– 1001.
9. Kairinos N, Voogd AM, Botha PH, Kotze T, Kahn D, Hudson DA, et al. Negative-pressure wound therapy II: negative-pressure wound therapy and increased perfusion. Just an illusion? PlastReconstr Surg. (2009) 123:601– 12.
10. Borgquist O, Ingemansson R, Malmsjö M. Wound edge microvascular blood flow during negative-pressure wound therapy: examining the effects of pressures from−10 to−175 mmHg. PlastReconstr Surg. (2010) 125:502– 9.
11. Kairinos N, McKune A, Solomons M, Hudson DA, Kahn D. The flaws of laser Doppler in negative-pressure wound therapy research. Wound Repair Regen. (2014) 22:424–9.
12. Muenchow S, Horch RE, Dragu A. Effects of topical negative pressure therapy on perfusion and microcirculation of human skin. ClinHemorheolMicrocirc. (2019) 72:365–74.
13. Sogorski A, Lehnhardt M, Goertz O, Harati K, Kapalschinski N, Hirsch T, et al. Improvement of local microcirculation through intermittent Negative Pressure Wound Therapy (NPWT). J Tissue Viability. (2018) 27:267– 73.