



Surgery

MODIFIED NEGATIVE PRESSURE WOUND THERAPY: A NOVEL APPROACH IN DEALING VARIOUS TYPES OF WOUND ENCOUNTERED AT ZONAL AND PERIPHERAL HOSPITAL SET UP

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ABSTRACT

Negative pressure wound therapy is one of wonderful discoveries in recent years for dealing various kinds of wound and is very effective. However, in peripheral as well as zonal hospital, such facility is hardly available and if available, it is very costly. The aim of this study was to report a modified form of NPWT and share its experiences gained in managing various wound at this centre.

MATERIAL & METHODS: Modified NPWT have been applied to 41 patients with various kinds of wound following debridement. In this modified NPWT, same principle of NPWT was used. However, Polyurethane foam (Car/ mattress), tubes (Romo Vac set) and suction machine were used respectively in places of NPWT foam (ROCF) and machine.

RESULTS: During the period from Jun 2019 to Jul 2020, 300 patients were admitted with various kinds of wounds. Of these, 41 patients met all inclusion, exclusion criteria and were willing for modified NPWT. Majority of the wound belong to infective etiology. Necrotizing soft tissue infection shared major chunk of infective wound. Wound following Crush injury and compartment syndrome were non-infective wound. The average debridement per wound and average sessions of NPWT are 1.88 and 1.97 respectively. Establishment of Such modified Negative Pressure wound therapy is comparatively very easy and cheap. Results were excellent without a single wound complication and NPWT failure. A velvety appearance of wound with healthy granulation tissue and epithelial growth at wound margin after modified NPWT was taken as a successful result.

CONCLUSION: Negative Pressure wound therapy is a very good modality of active wound management. This new modification of NPWT will cut heavily down the cost of treatment per wound. This new system can easily be established at peripheral surgical centre and will enable to provide benefits of NPWT. It will cut hugely down hospital expenditure.

KEYWORDS : NPWT Negative pressure wound therapy, NSTI Necrotizing soft tissue infection, VAC Vacuum assisted closure, Compartment syndrome, Crush Injury, PU Polyurethane, ROCF Reticulated open cell foam, SSG Split Skin Graft, m.indiamart.com, TLC Total leukocyte count

INTRODUCTION

Negative pressure wound therapy is one of wonderful discoveries in recent years for dealing various kinds of wound and is very effective (1) (2). Agenta et al and associates originally described the use of negative pressure to assist in wound closure in 1997 (1) (3) (4) (5). Other than immediate wound closure, Surgeons used this methods as adjunctive therapy before or after surgery or alternative to Surgery in extremely ill patients (1). However, in peripheral as well as zonal hospital, such facility is hardly available and if available, it is very costly (6). The aim of this study was to report a modified form of NPWT and share its experiences gained in managing various wound at this centre.

METHODS

This modified negative pressure Wound Therapy System used 4 components: (i) Car seat sponge or mattress foam made up of Polyurethane, which was placed directly over the wound forming a foam-wound interface; (ii) Opsite for airtight dressing; (iii) A Suction machine as negative pressure-generating device, which can generate a variable sub-atmospheric pressure and (iv) Tube (Romo VAC set) to connect Suction machine with PU foam.

Technique of Application: Steps:

- A) Wound was thoroughly debrided. All necrotic and fibrotic tissues were removed.
- B) Properly sterilized Polyurethane (mattress/car seat) foam was cut as per wound size and placed it over the wound. Overfilling is avoided.
- C) Opsite dressing were applied in airtight manner over the wound and Foam. Opsite was then cut 1 cm inner to wound margin.
- D) Another similar size foam was taken and then, two 16F Romo VAC suction tubes were inserted inside it. This complete set was placed over previously cut opsite area. Another sheet of opsite was taken and covered both systems in airtight fashion.
- E) These suction tubes were then connected to a suction machine.
- F) Wound was kept under negative pressure (125 mmHg) for continuous 2 hours and restarted after the break of half an hour. This cycle was repeated for 72h and then wound was reassessed. If there were healthy granulation tissue (velvety appearance) and Negative wound culture and sensitivity, SSG was performed to

provide definitive wound cover.

- G) Systemic features of infection like Fever, local features of infections like local raise of temperature, Erythema, Laboratory markers of infections like Serial TLC and Character of the drain output were monitored while its application.

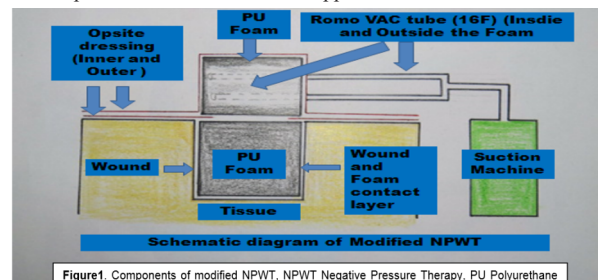


Figure1. Components of modified NPWT, NPWT Negative Pressure Therapy, PU Polyurethane

Table.1

Inclusion Criteria:	Exclusion criteria:
A) All age groups.	A) Malignant wound or wound which appears malignant.
B) Both genders.	B) Wound with untreated Osteomyelitis.
C) Patients who are willing to Modified NPWT.	C) Non-enteric or Unexplored Fistulas.
D) Wound after thorough debridement and after ensuring absence of necrotic and fibrotic tissue.	D) Known Allergies to Polyurethane foam or acrylic adhesives.
	E) Wound with localized Ischemia.
	F) Wound with exposed blood vessels, anastomotic sites, organs or nerves.

Study design

We conducted a prospective longitudinal based observational study to assess this novel technique and analyze advantages and disadvantages in respect of cost and results following application. Duration of the study was 14 months between 01 Jun 2019 and 31 Jul 2020. Permission of local institutional ethical committee was taken.

RESULTS

Summary of all 41 patients with their respective average debridement and NPWT sessions were given in **Table.2**. Necrotizing Soft Tissue Infection was the major etiology and frequently caused huge tissue loss inviting reconstruction. Mean requirement of debridement and

modified NPWT sessions per patient was 1.88 and 1.97 respectively. For establishing Modified NPWT, only requirement was PU foam (Table 2) and it was very cheap (**Table 3**) (6). This PU Foam started sticking to the wound if it was kept more than

Diagnosis	Number	Average Debridement	Average sessions of NPWT
1. Diabetic Foot	06	1.67 (10/6)	2 (12/6)
2. NSTI	20	2.2 (44/20)	2.15(43/20)
3. Fournier's Gangrene with Abdomino-perineal NSTI	01	4 (4/1)	3 (3/1)
4. SSI over Surgical wound	03	1.33 (4/3)	1.67 (5/3)
5. Compartment Syndrome	03	1 (3/3)	1.33 (4/3)
6. Cellulitis	05	1.6 (8/5)	1.4 (7/5)
7. Crush injury/ Traumatic wound	01	1 (1/1)	2 (2/1)
8. Venous Ulcer	02	1.5 (3/2)	2.5 (5/2)
Total	41	1.88 (77/41)	1.97 (81/41)



Figure 2. Some representative photographs of wound with various etiologies on initial presentation at this centre. 41 out of 300 patients consented for modified NPWT and satisfied all inclusion and exclusion criteria. All patients underwent serial aggressive debridement, modified NPWT and then SSG.

Table 3 : Components of NPWT vs Modified NPWT:

NPWT (Components)	Availability	Cost and Remarks	Modified NPWT (Components)	Availability	Cost and Remarks
1.NPWT machine	Not available	Rs 90,000/piece (KCI VAC therapy machine) at m.indiamart.com dated 01 Sep 2020.	1.Suction machine with Pressure indicator	Available	Not require to buy
2.NPWT canister	Not available	Rs 1,200/piece (LS NPWT/VAC Canister) at m.indiamart.com dated 01 Sep 2020.	2.Tubings of Romo Vac	Available	Not require to buy
3.NPWT Foam	Not available	Rs 9100/piece (Extricare NPWT foam Dressing, 30X60 cm) at m.indiamart.com dated 01 Sep 2020.	3.Car foam (Polyurethane)	Not Available	Rs 250/Sheet (1 Sheet = 3X6 Inch, thickness = 250 mm) at m.indiamart.com
4.Opsite dressing	Available	Not require to buy	4.Opsite dressing	Available	Not require to buy
			5.Autoclave machine	Available	Not require to buy

Minimum cost of per session of well established and commercial NPWT is Rs10300/- even after company's provision of free NPWT machine and Opsites (**Table 3**). On the other hand, maximum cost of Modified NPWT per session is Rs 250 (**Table 3**) Or cheaper (6). Repeated good results had been produced by this centre using these simple modifications (**Figure 3, 4 and 5**). By using this technique, total

number of dressings and durations of hospital stay were tremendously reduced with profound result. An velvety appearance of wound with healthy granulation tissue and epithelial growth at wound margin after modified NPWT was taken as positive result otherwise taken as failure (7). Not a single wound complication and failure was observed during the study.

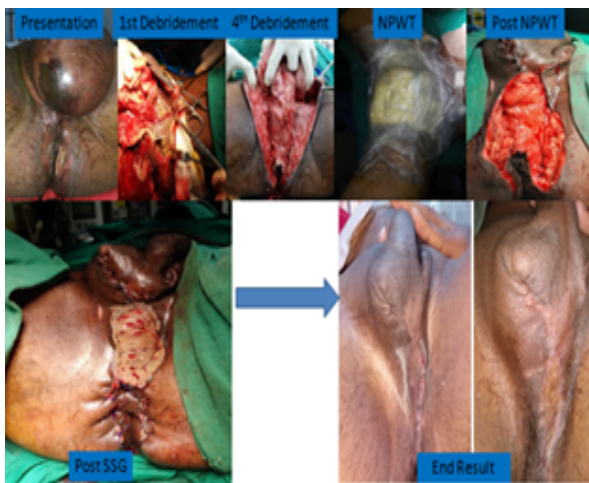


Figure3. 37 yrs old serving soldier with no known co-morbidities presented as Fournier's Gangrene with abdomino-perineal NSTI, underwent multiple sessions of debridement, loop-ileostomy, NPWT and SSG.



Figure 4. 60 yrs old, female with NSTI Left foot



Figure5. 54 yrs old, female with unknown bite (Optd) presented as Necrotizing soft tissue infection Left hand (optd) at our centre.

DISCUSSION

Management of various kinds of wound always throw many challenges to Surgeons both in Civil and Military set up (7). Early removal of non-viable tissues, foreign body, soil and focal or locus of infection by thorough wound debridement and good irrigation was the only key for successful outcomes in many wounds (7) (8) (9). Traditionally, post-wound debridement, the wound was managed with daily wound dressing followed by definitive wound closure (10). The TIME acronym, developed in June 2002 by a group of wound care experts, was first published in 2003 (11). Thus, look for new approach to wound is on. Agenta and Associates originally described the use of Negative pressure to assist in wound closure (1). The usefulness of NPWT was clearly seen in civilian traumatic and non-traumatic wounds (5) (12). The use of NPWT was widely reported during Operation Iraqi Freedom and OEF (7) (13) (14). There are several advantages of NPWT, which include reduced frequency of wound dressings as compared to conventional dressings (15), faster wound closure rates, and reduced local and systemic infection rates (16) (17) (18). Mechanisms of NPWT are multi-factorial (3) (5) and are (A) Macro-deformation, (B) Bioburden reduction, (C) Micro-deformation, (D) Reduction in tissue edema and (E) Enhanced cellular proliferation (1) (3) (9). NPWT reduces 78% in hospital stay and 76% decrease in cost (1). Armstrong and Lavery et al reported faster wound healing rate and faster granulation tissue formation rate (1) (19). Because of some drawbacks like high price (6) and non-availability at peripheral hospital set up, its extensive use is restricted in places where many of such wound are encountered. Most common complications in NPWT applications are bleeding and wound infection (20). Each patient in our study underwent mean debridement **1.88** and mean modified NPWT change **1.97** before their definitive reconstruction. No single wound complication (**0%**) (both infection and bleeding) was observed and such result is comparable to many of studies (6) (21)). Leininger et al. in their study reported 80% and 0% infection rate before and after introduction of NPWT (21). Peck et al. reported 4% infection rate in extremity war wounds treated by NPWT (22). All patients in our study underwent SSG after seeing a velvety appearance of wound after modified NPWT. Graft take in our study was **90% to 100%** without any wound or graft failure. NPWT enhances graft take (23), reduces seroma formation, and allows an early mobilization (6) (24) (25).

CONCLUSION

Timely and aggressive debrident followed by NPWT and prevention of infection play a key role in treatment of large wound requiring reconstruction. High cost of various components of NPWT and their availability restrict its extensive use in peripheral hospital set up. However, with introduction of above new modification of NPWT, it will cut down the cost of treatment per wound. It will help to provide benefit of NPWT to peripheral surgical set up as it is very easy to establish. It will broaden its use from rich patient to poor patient. It will cut heavily down hospital expenses and treatment budget of each patient. For better understanding and widespread application, further study comparing this new modified system to other commercially available systems may be required.

Financial support and sponsorship

Nil

Conflicts of interest

The authors have none to declare

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