Original Article

Journal of Orthopaedic Education
Volume 1 Number 1, January - June 2015

Negative-Pressure Wound Therapy in Wounds with External Fixators: A Simple and Cost Effective Technique

Friji Meethale Thiruvoth*, Ravi Kumar Chittoria, Devi Prasad Mohapatra***, Dinesh Kumar Shivakumar***, Sudhanva Hemant Kumar****, Arjun Ashokan****,Vijayaraghavan Nandhagopal******

Author Affiliation: *Associate Professor , **Head, ***Associate Professor, ****Resident, Department of Plastic Surgery, JIPMER, Pondicherry-605006 , India.

Reprint Request: Ravi Kumar Chittoria, Head, Department of Plastic Surgery, JIPMER, Pondicherry-605006 , India. E-mail: drchittoria@yahoo.com

Abstract

Introduction: Negative Pressure Wound Therapy (NPWT) is now an established modality of treatment used to treat various complex acute and chronic wounds in all surgical fields. However in treatment of wounds with external fixators, creation and maintenance of an air tight seal using conventional adhesive dressings is usually cumbersome and not effective. We present a simple, novel, cost effective technique of NPWT application using sterile cellophane dressing for wounds with external fixators. *Material and methods*: We present a series of 15 patients where NPWT was applied using sterile cellophane (cling wrap). All wounds with external fixators not amenable to skin grafting or flap in the primary setting were included. Sponge based continuous NPWT was used. The end point of NPWT was achieving healthy granulation tissue for wound cover. *Result*: All patients were successfully treated with NPWT. The mean duration of NPWT application was 15days. Healthy granulation tissue and wound contraction was noted in all patients making wounds amenable for cover. *Conclusion*: NPWT using cellophane is simple, cost effective and can be easily used to treat wounds with external fixators.

Key words: Negative Pressure Wound Therapy (NPWT); Cellophane; External Fixators.

Introduction

Negative pressure wound therapy has become a vital component in the armory of wound management and has been successfully used to augment and treat complex acute, sub-acute and chronic wounds. It has been used in orthopedics following spinal surgery, arthroplasty, open fractures, trauma etc [1–6].

However in treatment of wounds with external fixators, application of an air tight seal for NPWT with conventional adhesive dressings is not only difficult to apply but also leads to frequent failure to maintain air tight seal in between the pins of external fixator. We propose a novel , simple and cost effective technique of applying negative pressure in such wounds using a sterile plastic covering of cellophane(cling wrap).

Materials and methods

This is a prospective study performed at a tertiary care center in India between September 2014 and March 2015. The inclusion criteria included all wounds with external fixators not amenable to skin grafting or flap in the primary setting due to patient being unfit for surgery, hemodynamically unstable, wound infection, patient unwilling for free flap. All wounds with active bleeding, necrotic tissue, exposed vessels or nerves and patients allergic to cellophane were excluded from the study. All patients were who meet the prescribed criteria were explained about the

© Red Flower Publication Pvt. Ltd.

study. After obtaining informed consent, 15 patients were included in the study. Demographic details, details of injury and wound, tissue culture sensitivity, pre-NPWT photographs and photographs of every dressing were recorded. NPWT was changed every 3rd day or when NPWT stopped working. The end point of NPWT was achieving healthy granulation tissue for wound cover (tissue culture negative). Total number of dressing change and total duration to attain healthy granulation tissue was noted. No statistical analysis was performed due to small sample size.

Results

Total of 15 patients was included in the study. The mean age of the patients was 37 years (range 18–66 years). There were 11 males and 4 females in this study. Upper limb was involved in 3 patients and 12 patients had lower limb injuries. Out of the 15 patients included in the study, 8 patients had associated crush injury, 5 patients had wound infection and the 2 patients were hemodynamically unstable. The duration of NPWTapplication ranged from 5-12 days with a mean of 8days. All 15 patients having wounds with external fixators could be successfully treated with NPWT. An Airtight seal could be easily created and maintained using sterile cellophane around the external fixators. The dressings were changed on every 3rd day as planned in 13 out of 15 patients. 2 patients required re-application of NPWT more than once in between the dressing period for bedside debridement following which good response was noted. Granulation tissue was noted in all patients. No instances of bleeding requiring cessation of therapy were noted.

Discussion

The concept of Negative Pressure Wound Therapy (NPWT) dates back to 1940's [7, 8] . Its effectiveness in wound healing was first published by Charker et al in 1989 [9]. Fleischmann et al. was the first to manage chronic wounds with sub-atmospheric pressure in 1993 [10]. Morykwas et al. was the first to describe the efficacy of NPWT [11]. In 1997, Argenta et al. successfully used open pore polyurethane dressings under negative pressure for complicated wounds of the torso and extremities [12]. Vacuum Assisted Closure (VAC) a commercially available form of NPWT was first introduced in the United States of America by Kinetic Concepts Inc. (Texas) in 1996 which was approved later by FDA in 2002 December. Since the inception of NPWT, it has been successfully used to accelerate wound healing in wide range of acute, sub-acute and chronic wounds [13] including pressure ulcers [14,15], diabetic ulcers [16,17], traumatic wounds [18,19], open fractures [1–3], following failure of arthro-plasty or spinal surgery [4–6], burns[20], before and after skin grafting [21], etc.

Mechanism of action

It involves application of negative pressure with the help of a suction tube connected to a suction apparatus applied over gauze or sponge placed over the wound and sealed in an airtight manner with an adhesive dressing. NPWT acts by stimulating angiogenesis, increase tissue perfusion, removal of excess exudate, reducing peri-wound edema, provides a moist environment, contraction of wound edges and promoting granulation tissue [22–25] NPWT is an adjuvant to promote wound healing is not a replacement to traditional wound management measures to control infection and surgical debridement.

It is contraindicated in the presence of exposed vessels, nerves or anastomotic site, in the presence of active bleeding, malignancy, allergy to adhesive dressing or silver based foam, overwhelming infections requiring debridement [1].

The problem statement

Complex wounds with extensive tissue loss, for example, Type IIIGustillo fractures with skin loss and exposed bones often requires complex microvascular tissue transfer. With the advent of negative pressure wound therapy, many such wounds can be made to granulate and subsequently treated with a simpler procedure like split skin graft. However, the presence of external fixators poses a challenge in obtaining air tight closure due to the difficult maneuverability in application over wounds with external fixators and to maintainan uniform airtight seal. Repeated dressings with transparent adhesive adherent dressings add to thecost. The cellophane on the other hand is easily available and costs only Rs 75 for 100 meters. It can be rolled and cut to different sizes prior to sterilization by ethylene oxide, thus making its maneuverability around the external fixator pins easy. The cost of the entire NPWT dressing utilizing a ryles tube and cellophane comes to around Rs. 34 per dressing (excluding sterilisation charges).

In our study technique, Sponge based NPWT with sterile cellophanewith continuous negative pressure

obtained via wall suction device connected via a Ryle's tube was used. The cellophane was sterilized by ethylene oxide method after unwrapping and rolling it around plastic sticks of size required. This sterilized cellophane could be cut into different sizes to easily roll around and under the external fixators to maintain airtight dressing. In our study we found NPWT could easily be applied and maintained over these wounds with external fixators. The easy availability of the equipment, simplicity of procedure, low cost, ease of sterilization & easy maneuverability of cellophane over any surface make it a cost effective alternative to the VAC system and can be easily used for all kinds of wounds promoting wound healing.

Table 1: Patient and Wound Details

Sl no.	Age (yrs)	Gender	Diagnosis	Size of the wound (cm)	Duration of application of NPWT(days)	Number of dressing changes
1	55	M	Right leg Type III b tibia fracture	5cm x 8 cm	12	4
2	22	F	Left Footcompound metatarsal heads fracture	7 cm x 10 cm	9	4
3	54	M	Right leg Type III a fracture tibia	4 cm x 6cm	8	3
4	50	M	Type III b Left Lower limbboth bone fracture	10cm x 8cm	11	4
5	29	M	Left forearm compound radial fracture	4cm x 8cm	10	4
6	28	F	Left leg Type IIIa tibia fracture	2cm x 3cm	5	2
7	42	M	Right footcompound metatarsal head fracture	4cm x 7 cm	7	3
8	18	M	Rightcompound femur fracture,	12cm x 10cm	12	6
9	31	M	Left leg Type III b compound fracture tibia	3cm x 2cm	6	3
10	51	M	Right compound femur fracture	13 cm x 10cm	12	4
11	47	M	Right Type III b tibia fracture	6cm x 8 cm	8	3
12	51	M	Left leg type III a tibia fracture	4cm x 4 cm,	5	3
13	66	M	left leg Type III b fracture tibia,	5cm x 3 cm	6	2
14	33	F	Open right distal 1/3rd radius fracture	4cm x 2cm	5	2
15	27	F	Both bonefracture Right upper limb	3cm x 2 cm	6	3

Fig. 1: Sterilized Cellophane roll

Fig. 2: Cellophane NPWT Dressing in situ

Conclusion

NPWT using cellophane is simple, cost effective and can be easily used to treat wounds with external fixators.

References

1. Dedmond BT, Kortesis B, Punger K , Simpson J, Argenta J, Kulp B et al. The use of negative-pressure wound therapy (NPWT) in the temporary treatment of soft-tissue injuries associated with high-energy open tibial shaft fractures. J Orthop Trauma.2007; 21(1): 11–7.
2. Rinket B, Amspacher JC, Wilson PC, Vasconcz HC. Subatmospheric pressure dressing as a bridge to free tissue transfer in the treatment of open tibia fractures. PlastReconstr Surg.2008; 121(5): 1664–73.
3. Bhattacharyya T, Mehta P, Smith M, Pomahac B. Routine use of wound vacuum-assisted closure does not allow coverage delay for open tibia fractures. Plastic Reconstr Surg.2008; 121(4): 1263–6.
4. DeFranzo J, Argenta LC, Marks MW, Molnar JA, David LR, Webb LX et al. The use of vacuum-assisted closure therapy for the treatment of lower-extremity wounds with exposed bone. Plastic ReconstrSurg.2001; 108: 1184–1191
5. Kiliç A, Ozkaya U, Sökücü S, Basilgan S, Kabukçuoðlu Y. Use of vacuum-assisted closure in the topical treatment of surgical site infections. ActaOrthopTraumatolTurc.2009; 43: 336–342 (in Turkish).
6. Labler L, Keel M, Trentz O, Heinzelmann M. Wound conditioning by vacuum assisted closure (V.A.C.) in postoperative infections after dorsal spine surgery. Eur Spine J.2006; 15: 1388–1396.
7. Fay MF. Drainage systems.Their role in wound healing. AORN J 1987; 46: 442e55.
8. Fox 4th JW, Golden GT. The use of drains in subcutaneous surgical procedures. Am J Surg. 976; 132: 673e4.
9. Chariker ME, Jeter KF, Tintle TE, Bottsford JE. Effective management of incisional and cutaneous fistulae with closed suction wound drainage. Contemp Surg.1989; 34: 59–63.
10. Fleischmann W, Strecker W, Bombelli M, Kinzl L. Vacuum sealing as treatment of soft tissue damage in open fractures. Unfallchirurg.1993; 96: 488–492.
11. 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 Plast Surg.1997; 38: 553–562.
12. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. Ann Plast Surg.1997; 38: 563–577.
13. KCI. The V.A.C. therapy clinical guidelines: a reference source for clinicians [report on the Internet] Kinetic Concepts, Inc. 2005. Jul 1, 2006.
14. Ford CN, Reinhard ER, Yeh D, Syrek D, De Las Morenas A, Bergman SB, et al. Interim analysis of a prospective, randomized trial of vacuum-assisted closure versus the healthpoint system in the management of pressure ulcers. Ann PlastSurg.2002; 49: 55e61.
15. Wanner MB, Schwarzl F, Strub B, Zaech GA, Pierer G. Vacuum assisted wound closure for cheaper and more comfortable healing of pressure sores: a prospective study. Scand J PlastReconstrSurg Hand Surg.2003; 37: 28e33
16. Eginton MT, Brown KR, Seabrook GR, Towne JB, Cambria RA. A prospective randomized evaluation of negative-pressure wound dressings for diabetic foot wounds. Ann VascSurg 2003; 17: 645e9.
17. Armstrong DG, Lavery LA. Diabetic Foot Study Consortium: negative pressure wound therapy after partial diabetic foot amputation: a multicentre, randomized controlled trial. Lancet 2005; 366: 1704e10.
18. Stannard JP, Robinson JT, Anderson ER, McGwin Jr G, Volgas DA, Alonso JE. Negative pressure wound therapy to treat hematomas and surgical

incisions following high-energy trauma. J Trauma 2006; 60: 1301e6.

19. Llanos S, Danilla S, Barraza C, Armijo E, Pin˜eros JL, Quintas M. Effectiveness of negative pressure closure in the integration of split thickness skin grafts: a randomized, double-masked, controlled trial. Ann Surg.2006; 244: 700e5.
20. Chio EG, Agrawal A. A randomized prospective controlled study of forearm donor site healing when using a vacuum dressing.Otolaryngol Head Neck Surg. 2010; 142(2): 174–8.
21. Llanos S, Danilla S, Barraza C , et al. Effectiveness of negative pressure closure in the integration of split thickness skin grafts: a randomized, double masked controlled trial. Ann Surg. 2006; 244(5): 700–5.
22. Otgill DP, Manders EK, SumpioBE , et al. The mechanisms of action of vacuum assisted closureL More to learn.Surgery. 2009; 146(1): 40–51.
23. Scherer SS, Pietramaggiori G, Mathew JC, Prsa MJ, Huang S, Orgill DP. The mechanisms of action of the vacuum assisted closure device. PlastReconstr Surg. 2008; 122(3): 786–97.
24. Gurtner GC, Werner S, Barrandon Y, Longaker MT. Wound repair and regeneration. Nature.2008; 453: 314–21
25. Webb LX, Pape HC. Current thought regarding the mechanism of action of negative pressure wound therapy with reticulated open cell foam. J Orthop Trauma. 2008; 22(Suppl. 10): S135–7.