International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(3): 110-113

https://www.orthopaper.com
Received: 11-06-2023
Accepted: 20-07-2023

Dr. AT Mithun Athiraj
Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. Subramanian RM
Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. S Partheeswar
Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. S Navaneetha krishnan
Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. Yeshwanth Subash
Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Corresponding Author:
Dr. Yeshwanth Subash
Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Negative pressure wound therapy in soft tissue injury and open fractures around ankle and foot

Dr. AT Mithun Athiraj, Dr. Subramanian RM, Dr. S Navaneetha Krishnan, Dr. S Partheeswar and Dr. Yeshwanth Subash

DOI: https://doi.org/10.22271/ortho.2023.v9.i3b.3417

Abstract
Background: Negative Pressure Wound Therapy (NPWT) is frequently utilized to manage complex wounds around foot and ankle. Changes in growth factor expression, micro- and macro-deformation, blood flow, exudate removal, and bacterial concentration within the wound bed are thought to play a role. This study was performed to evaluate the results of negative pressure wound therapy (NPWT) in patients with open wounds in the foot and ankle region.
Methods: this was a prospective study of 30 patients with soft tissue injury and open fractures around foot and ankle conducted between April 2022 to April 2023 with a follow up period of 1 year.
Results: There were 19 male and 11 female patients in our study with right side being more commonly affected in 17 patients and foot region being more commonly involved. Exposed tendons and bones were successfully covered with healthy granulation tissue in all cases. The mean age of the patients was 40.3 ranging from 22 to 62 years. Mean wound size at treatment initiation was 52.1 cm^2 ranging from 32 to 96 cm^2 and this reduced to 20.8 cm^2 ranging from 10 to 42 cm^2 at treatment completion. No major complication occurred that was directly attributable to treatment. In terms of minor complications, six patients developed superficial infections.
Conclusion: NPWT was found to facilitate the rapid formation of healthy granulation tissue on open wounds in the foot and ankle region, and thus, to shorten healing time and minimize secondary soft tissue defect coverage procedures.

Keywords: NPWT, VAC, foot, ankle, healing

Introduction
Modern surgical methods, implants, and materials have made it easier for surgeons to treat injuries of the foot and ankle that were once incapacitating. Knowing how to treat wounds requires knowledge and experience. Acute and chronic wounds can result from a variety of etiologies, including trauma and infection [1]. Depending on the extent of the wound, the exposed structures, and the patients' co-morbid conditions, these wounds are managed differently. Through adjustments in growth factor expression, micro- and macro-deformation, blood flow, exudate clearance, and bacterial concentration within the wound bed, negative pressure wound therapy (npwt) is a technique for wound care [2, 3, 4]. When applying npwt devices in dynamic areas, it is possible to see a sizable shrinkage of the wound as the wound edges are drawn together by foam contact and foam shrinkage. The foam induces micro deformations at the wound interface that stretch cells and trigger cellular division and angiogenesis molecular pathways. For wounds with edema, these devices have the capacity to remove a large amount of fluid. Additionally, the dressing serves as an insulator to keep the wounds warm and moist because of the materials utilised to cover it. In our practise, we employ these devices after debriding the wounds and making sure there is no obvious necrotic material still present. They can be used until the wound is closed or used in preparation for surgical closure such as a skin graft or flap. Since the porous interface material is so effective at sucking up blood, the suction device must have the proper alerts to prevent exsanguination [5]. The aim of this study is to analyse the outcome of negative pressure wound therapy in foot and ankle injuries.

Materials and Methods

This was a prospective study of 30 patients with soft tissue injury and open fractures around foot and ankle between April 2021 to April 2022 at the department of orthopedics, Saveetha medical college and hospital, Thandalam. All patients were seen either at the outpatient or the emergency department and following admission, a thorough history was taken with details time since injury to presentation to the hospital and physical examination was carried out. Local examination of affected foot and ankle were recorded in the patient's case records (Table 1). Routine blood investigations were done. The patients needed for wound debridement prior to npwt were taken up for procedure after obtaining informed consent and anaesthetic fitness for surgery. All patients had experienced an acute injury caused by either road traffic accidents, workplace injury and crush injury and all of them had at least one tendon or bone exposed at the initiation of npwt some of them had an associated infection.

Technique: A NPWT device was applied after debriding necrotized tissues and cleansing contaminated wounds. When fractures were present, internal or external fixation was performed before application. The vac system was used throughout. This consists of an evacuation tube, a collecting canister, a vacuum pump, and a multiporous sponge, which directly contacts the wound. The sponge, which was designed to be 3–5 cm larger than wounds, was applied to defect sites and sealed with transparent cohesive film. The vacuum dressing was changed every 3–4 days and most procedures were performed at bedside. A negative pressure vacuum pump was applied to wounds in continuous mode at a pressure of 100~125 mm hg. NPWT was stopped after confirming the formation of healthy granulation tissue. Skin grafting was performed when further coverage was required. Wound types and location were noted, and durations, numbers, and frequencies of vac system application were recorded. Before and after NPWT treatment, sizes of soft tissue defect were assessed. Final coverage techniques, including primary closure, split thickness skin grafting, and pedicled local and vascularized free flap grafting were documented. Furthermore, any complications attributable to npwt treatment were noted. Statistical analysis was performed using SPSS v24 (IBM, united states of America). Statistical significance was accepted with P-values <0.05.

Results

30 patients of soft tissue injury & open fractures around foot and ankle treated with negative pressure wound therapy (vac dressing) were studied between April 2022 to April 2023. There were 19 males and 11 females patients in our study with right side being more commonly affected in 17 patients and foot region being more commonly involved (Figure 1). The mean age of the patients was 40.3 ranging from 22 to 62 years. The most common mode of injury was road traffic accident followed by work place injury. The mean duration of therapy was 12.6 days ranging from 10 to 16 days and dressings were changed 3.5 times on average. Mean wound size at treatment initiation was 52.1 cm^2 ranging from 32 to 96 cm^2 and this reduced to 20.8 cm^2 ranging from 10 to 42 cm^2 at treatment completion, an average wound area reduction of 37%. 27 of the 30 patients achieved improved wound status, and in these exposed tendons or bone was covered with healthy granulation tissue (Table 2). After negative pressure wound therapy, skin grafting was done in 11 patients to cover granulation tissue. The average wound grade was 1.9 at the start of treatment and 1.1 at the end of treatment Table 3). Patients who underwent wound debridement prior to npwt showed faster granulation tissue formation. No complication occurred that could be directly attributed to negative pressure wound therapy, such as, a deep infection or bleeding. Superficial soft tissue infection was seen in 6 patients which settled down well after treatment with appropriate intravenous antibiotics. All patients returned to their pre-injury status after 4-6 weeks of injury. None of our patients were lost follow up.

Discussion

Traumatic wounds around the foot and ankle are frequently accompanied by considerable skin loss, which exposes tendons, bone, or metal and causes problems with wound care. These wounds resemble chronic ulcerative lesions of the foot linked to ischemia illnesses like diabetes mellitus in many aspects. The rapid formation of granulation tissue and blood vessels are essential for the healing of these wounds. Such cases are treated with repeated wet dressing changes (3–4 times/day), although the treatment is drawn-out and uncomfortable [6, 7]. Furthermore, because it contains collagenase and metalloproteinase, interstitial fluid from open wounds decreases local blood flow and interferes with wound healing [8, 9]. After 4 sponge changes, the majority of our patients' wounds were covered with good granulation tissue without the need for extra flap surgery. Additionally, NPWT is said to accelerate granulation formation in over 80% of patients when compared to a straightforward wet dressing. The formation of new vasculature and granulation tissues is also enhanced by the continual physical stimulus that NPWT offers, according to well-reported research [10, 11, 12].

As a result of the minimal granulation tissue production in the foot and ankle region, soft tissue lesions in these areas typically require local or free flap surgery instead of skin grafting. For lesions involving the weight-bearing surface of the foot as well as those with exposed bone or neurovascular systems, a split-thickness skin graft is not advised [13]. Lawnmower injuries to the lower leg were the subject of a comparative research of conventional dressings and NPWT, and it was discovered that the latter reduced the need for free flap surgery by 30% [14]. The NPWT is thought to have a significant advantage in that the need for further soft tissue operations is significantly reduced. Additionally, Dedmond *et al* noted that grade 3 wounds with an accompanying open tibial fracture healed without the need for surgery [15]. Lee *et al* reported on 16 patients with severe open traumatic wounds of the foot and ankle using NPWT. Before applying NPWT, the authors irrigated and debrided necrotic and contaminated tissue and fixated fractures, if present. Negative pressure was applied continuously at 100-125 mmHg. The mean reduction in wound size was 24%. In 15 patients, the wound bed granulated sufficiently to apply an STSG to achieve closure. One patient required a free flap. No major complications occurred [16].

Deep infection prevention is critical during the treatment of soft tissue abnormalities, and simple wet dressing may be insufficient in this context because wounds are invariably exposed to the environment. NPWT, on the other hand, not only closes open wounds but also evacuates hematomas, exudates, and potential infections by the use of negative pressure. Tan *et al*., in a study of 68 patients, compared NPWT (35 patients) with conventional treatment (33 patients) and found significantly fewer recurrences of infection, a decreased need for tissue transfers or muscle flaps, and more

wounds with bacterial clearance in those treated with NPWT. It has been reported that NPWT is effective at treating deep infections [17].

In terms of complications, we did encounter 3 patients with superficial skin infections, which can lead to delayed wound healing. Skin infections were controlled successfully with the help of appropriate intravenous antibiotics.

In our study we had a wound healing rate of 45% with no cases of any wound infection at the time of last follow up. The lack of major complications seen in our study could be due to the fact that proper sterile dressing technique while applying VAC dressing. We also reviewed studies of other authors & noted that there were good wound healing rates reported in most of the studies which compares well with the result of our study. We thereby conclude by stating that negative pressure wound therapy is a good option for the management of open fractures and soft tissue injuries around foot and ankle. It prevents deep infections of injured site and promotes wound healing in deeper wounds.

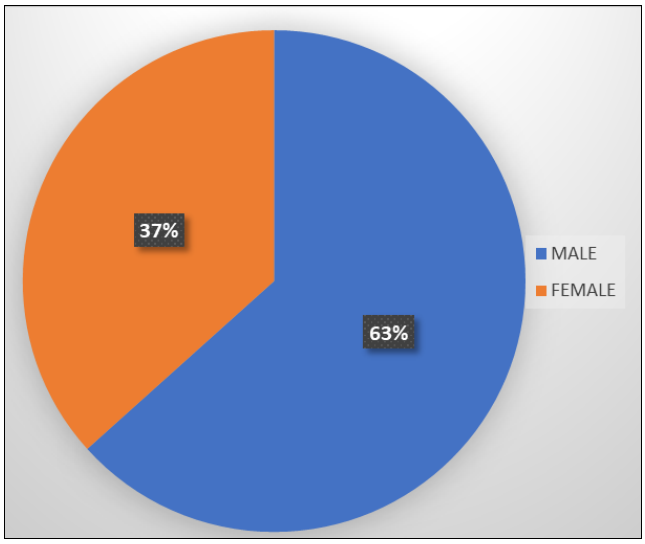

Fig 1: Gender distribution

Table 1: Details of the open wound scoring system used

Score (grade)	Status of wound
0	Closed wound
1	Skin or soft tissue defect
2	Bone, tendon, implant exposure (Any 1)
3	Bone, tendon, implant exposure (Any combination of 2 or more)
4	Associated or Residual infection

Table 2: Patient's demographics and data

S. No	Age	Sex	Mode of Injury	Side	Site of Injury	Injury Time to Vac Application (Hrs)	Previous Surgical Procedure	Wound Grade	Size Before Therapy (Cm^2)	Size After Therapy (Cm^2)	Duration (Days)	Complication
1	22	M	RTA	Right	Foot	24	Debridement	2	50	20	14	Nil
2	27	M	Workplace injury	Left	Ankle	12	Debridement	2	66	27	11	Nil
3	35	M	RTA	Left	Foot	14	Debridement	3	45	15	10	Nil
4	56	M	RTA	Right	Ankle	20	None	1	84	21	15	Nil
5	47	F	RTA	Left	Foot	48	Debridement	2	63	24	13	Nil
6	32	M	RTA	Left	Foot	26	Debridement	3	48	12	12	Superficial infection
7	29	M	RTA	Right	Foot	16	None	1	56	12	11	Nil
8	36	F	Workplace injury	Right	Ankle	18	Debridement	2	96	32	11	Nil
9	52	M	RTA	Left	Foot	12	Debridement	3	49	10	10	Nil
10	62	F	RTA	Right	Ankle	15	None	1	53	16	16	Nil
11	59	M	Workplace injury	Right	Ankle	8	None	1	60	42	14	Nil
12	33	M	RTA	Left	Foot	10	Debridement	2	33	13	12	Superficial infection
13	53	F	RTA	Right	Foot	16	Debridement	2	47	17	10	Nil
14	26	M	Workplace injury	Right	Ankle	4	None	2	53	23	15	Nil
15	38	M	RTA	Left	Foot	14	Debridement	3	39	17	14	Nil
16	57	F	RTA	Right	Ankle	16	None	2	41	19	11	Superficial infection
17	29	M	RTA	Right	Foot	20	None	1	52	25	16	Nil
18	44	F	Workplace injury	Left	Ankle	24	Debridement	1	71	32	13	Nil
19	35	M	RTA	Right	Foot	14	None	2	32	14	10	Superficial infection
20	61	F	RTA	Right	Foot	16	Debridement	2	48	21	13	Nil
21	44	M	RTA	Left	Foot	18	None	3	38	16	15	Nil
22	37	F	Workplace injury	Left	Foot	10	Debridement	3	59	26	16	Superficial infection
23	53	M	RTA	Right	Ankle	4	Debridement	2	37	15	13	Nil
24	48	M	RTA	Left	Ankle	15	None	1	45	20	12	Nil
25	26	F	RTA	Right	Ankle	10	Debridement	2	54	23	11	Nil
26	36	M	Workplace injury	Left	Foot	18	Debridement	3	63	27	10	Nil
27	43	F	RTA	Right	Foot	15	Debridement	2	40	19	13	Superficial infection
28	40	M	Workplace injury	Right	Foot	12	Debridement	2	54	26	13	Nil
29	31	M	RTA	Left	Foot	5	Debridement	3	43	23	14	Nil
30	38	F	RTA	Right	Ankle	9	Debridement	1	46	18	11	Nil

Table 3: Mean demographic data of the study

	Age	Injury time to vac application (hrs)	Wound grade at the end of treatment	Wound size before (cm^2)	Wound size after (cm^2)	Duration (days)
Mean	40.3 yrs	15.4	1.9	52.1	20.8	12.6
Range	22-62 yrs	4-48	1-3	32-96	10-42	10-16

Conclusion

Our findings contribute to the increasing number of evidence that NPWT is an effective supplementary treatment for soft tissue injury and open fractures around the foot and ankle. It was discovered in the current investigation to facilitate the quick production of granulation tissue, to shorten healing time, and to significantly reduce the need for additional soft tissue reconstructive surgery.

Competing interests

The authors declare that they have no competing interests.

Conflict of Interest

Not available

Financial Support

Not available

References

1. Mendonca DA, Cosker T, Makwana NK: Vacuum-assisted closure to aid wound healing in foot and ankle surgery. Foot Ankle Int. 2005;26:761-766.
2. Lee HJ, Kim JW, Oh CW, *et al*. Negative pressure wound therapy for soft tissue injuries around the foot and ankle. J Orthop Surg Res. 2009;4:14.
3. Moues CM, van Toorenenbergen AW, Heule F, Hop WC, Hovius SE. The role of topical negative pressure in wound repair: expression of biochemical markers in wound fluid during wound healing. Wound Repair Regen. 2008;16(4):488- 494
4. Xia CY, Yu AX, Qi B, Zhou M, Li ZH, Wang WY. Analysis of blood flow and local expression of angiogenesis associated growth factors in infected wounds treated with negative pressure wound therapy. Mol Med Rep. 2014;9(5):1749- 1754.
5. Huang C, Leavitt T, Bayer LR, Orgill DP. Effect of negative pressure wound therapy on wound healing. Curr Probl Surg. 2014 Jul;51(7):301-31. doi: 10.1067/j.cpsurg.2014.04.001. Epub 2014 Apr 26. PMID: 24935079.
6. McCallon SK, Knight CA, Valiulus JP, Cunningham MW, McCulloch JM, Farinas LP: Vacuum-assisted closure versus saline-moistened gauze in the healing of postoperative diabetic foot wounds. Ostomy Wound Manage 2000, 46:28-32.
7. Lionelli GT, Lawrence WT: Wound dressings. Surg Clin North Am. 2003;83:617-638.
8. Bucalo B, Eaglstein WH, Falanga V. Inhibition of cell proliferation by chronic wound fluid. Wound Repair Regen. 1993;1:181-186.
9. Wysocki AB, Staiano-Coico L, Grinnell F: Wound fluid from chronic leg ulcers contains elevated levels of metalloproteinases MMP-2 and MMP-9. J Invest Dermatol. 1993;101:64-68.
10. 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.
11. Yuan-Innes MJ, Temple CL, Lacey MS: Vacuum-assisted wound closure: A new approach to spinal wounds with exposed hardware. Spine. 2001;26:E30-33.
12. DeFranzo AJ, Marks MW, Argenta LC, Genecov DG: Vacuum assisted closure for the treatment of degloving injuries. Plast Reconstr Surg. 1999;104:2145-2148.
13. Alonso JE, Sanchez FL: Lawn-mower injuries in children: a preventable impairment. J Pediatr Orthop 1995;15:83-89.
14. Shilt JS, Yoder JS, Manuck TA, Jacks L, Rushing J, Smith BP: Role of vacuum-assisted closure in the treatment of pediatric lawnmower injuries. J Pediatr Orthop. 2004;24:482-487.
15. Dedmond BT, Kortesis B, Punger K, Simpson J, Argenta J, Kulp B: Subatmospheric pressure dressings in the temporary treatment of soft tissue injuries associated with type III open tibial shaft fractures in children. J Pediatr Orthop. 2006;26:728-732.
16. Lee HJ, Kim JW, Oh CW, *et al*. Negative pressure wound therapy for soft tissue injuries around the foot and ankle. J Orthop Surg Res. 2009;4:14.
17. Li J, Topaz M, Tan H *et al*. Treatment of infected soft tissue blast injury in swine by regulated negative pressure wound therapy. Ann surg. 2013;257(2):335-344.

How to Cite This Article

AT Mithun Athiraj, RM Subramanian, S Navaneetha Krishnan, S Partheeswar, Y Subash. Negative pressure wound therapy in soft tissue injury and open fractures around ankle and foot. International Journal of Orthopaedics Sciences. 2023;9(3):110-1113.