International Journal of Research in Medical Sciences
Mir MA et al. Int J Res Med Sci. 2021 May;9(5):1329-1334
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20211412

Original Research Article

Customized vacuum assisted closure therapy of wounds as a simple and cost-effective technique of wound closure-a prospective observational study from underdeveloped world

Mushtaq A. Mir, Tajdin Wani, Tahir Saleem Khan*, Syed Mushtaq Ahmad Shah, Ravi Kumar, Zahoor Ahmed Naikoo, Bashir Ahmed Bhat

Department of Surgery, Government Medical College Srinagar, Jammu and Kashmir, India

Received: 15 March 2021
Accepted: 30 March 2021

***Correspondence:**
Dr. Tahir Saleem Khan,
E-mail: khants2000@gmail.com

ABSTRACT

Background: Aim of the study was to study the efficacy and cost-effectiveness of indigenously designed customized vacuum assisted closure (VAC) of wounds in our patients. The management of difficult to heal wounds has been the main force that led to the development of advanced gadgets for their management. The technique of vacuum assisted closure has revolutionized the management of difficult to heal wounds and delivers better results as compared to conventional technique. Our aim was to assess the efficacy and cost effectiveness of customized VAC therapy.
Methods: This prospective study was conducted in the department of surgery and allied specialties, GMC Srinagar, from June 2018 and September 2020. During this period, 80 patients were subjected to VAC therapy and were included in this study.
Results: VAC dressing was used in 80 patients. 55 were males and 25 were females. Most of the wounds in our study were located over lower limbs (70%). RTA was the most common mode of injury followed by fall from height. After the VAC therapy, 78.8% patients were managed by STSG, 11.3% by flap cover, 6.3% by secondary suturing and 3.8% healed by secondary intention. Pain was experienced by 30% of the patients, 7.5% had hypoalbuminemia, 3.8% had surrounding skin maceration. The average total cost of the VAC therapy was 863.13 (±399.82) Indian rupees (11.76 USD). The mean duration of hospital stay for our patients was 22 days.
Conclusions: Customized VAC Therapy has revolutionary potential in the management of the difficult to treat wounds as far as its safety, speed and cost effectiveness is considered especially in a setup of poor income nations like ours.

Keywords: VAC, Negative pressure wound therapy, Wounds, Cost effectiveness, Customized

INTRODUCTION

The management of difficult to heal wounds has been the main force that led to development of advanced gadgets for their management. Wounds of patients in need of reconstructive surgery are frequently large with extensive soft tissue loss. There are a variety of pharmacological, cellular, biochemical, and mechanical methods that alter the normal wound healing sequence.[1-3] In recent past, there has been surge in research for management of non-healing wounds by both surgical and non-surgical methods. Among the methods, negative pressure wound therapy (NPWT) which was described by Fleischman et al, in 1993, who first reported use of sub atmospheric pressure for an extended period to promote wound debridement and healing.[4] NPWT or VAC therapy of the wounds have 4 primary effects on the wounds i.e.,- (1) contraction of the wound (macro-deformation); (2) stabilization of the wound environment; (3) removal of wound exudate and decrease in edema; and (4) micro-deformation of the foam-wound inter-face.[5,6] Apart from

these primary effects, various secondary effects of the VAC therapy are- 1) It Speeds up wound healing compared to normal saline dressings. 2) Increase in blood flow around the wounds by increased granulation tissue with small blood vessels observed on histological sections. 3) Causes changes in Bacterial bio-burden. 4) Changes in wound biochemistry and systemic response through depressing the expression of MMP-1, 2, 13 and also depressing the degradation of collagen and gelatin. 5) Improvement in wound bed preparation by increase in granulation tissue formation by greater than 60%, when applied to porcine wounds in comparison to wounds treated with moist gauze dressing.[7-11] Also, it has been seen that granulation tissue covered the wound more quickly in patients treated with VAC device, resulting in faster wound closure, than in patients receiving standard treatment.[12]

Aim of the study was to study the efficacy and cost-effectiveness of indigenously designed customized vacuum assisted closure of wounds in our patients.

METHODS

The present prospective observational study was conducted in the post-graduate department of surgery and allied specialties, government medical college, Srinagar, Kashmir, India. This study was conducted from June 2018 to September 2020. Ethical clearance for the study was taken from the ethical committee of the hospital.

Patients admitted with wounds of different etiologies in the department of surgery and allied specialties, after initial debridement and management were subjected to indigenously devised vacuum assisted wound therapy using wall mounted suction apparatus. The patients/attendants were explained the procedure and informed written consent was taken. The patients were kept in a comfortable position and it was ensured that patient had received adequate analgesia before the procedure. All patients having different types of wounds were subjected to wound preparation in terms of debridement of any necrotic tissue, cleansing of wound with normal saline irrigation and appropriate hemostasis prior to application of vacuum device. The hair of the patient was shaved around the margins of the wound (where needed). An appropriate size of sterilized polyurethane foam was selected and contoured to fit on the wound surface without overlapping skin edges. It was ensured that the foam filled all areas of the wound including any tunnel or undermining. The tubing was placed onto the foam and then a sterile transparent adhesive dressing (Iodrape) was applied over the wound and foam allowing at least 3-5 cm of coverage onto healthy tissue to assure proper occlusive seal. By this, open system was converted into closed system which was open through tubing only. After that a wall mounted suction device unit was connected to the tubing and was set to the desired pressure (75-125 mmHg). The patients were subjected to VAC therapy in a continuous manner.

The VAC dressing was changed at serial intervals (after 48-72 hours) depending upon the nature and output of the wound and the efficacy of the VAC therapy in the management of wounds was assessed. The wound of the patient was serially photographed and the wounds were serially examined by one of the senior members of the attending team to determine the wound contraction and development of granulation tissue at each dressing change. End point of the therapy was selected when the wound was completely covered by granulation tissue.

RESULTS

In our study the age ranged from 10 to 80 years with majority i.e., 20 patients (25%) being 31-40 years of age. (Table 1). There were 55 males (68.7%) and 25 females (31.3%), with Male: Female ratio of 2.2:1 respectively.

The most common site of wounds in our study was legs, presents in 20 patients (25%) followed by thigh in 14 patients (17.5%) and foot in 10 patients (12.5%) making the lower limb the most common area of the body involved (Table 2). In our study road traffic accidents (RTA) comprised the most common mode of injury present in 24 patients (30%) followed by necrotizing fasciitis in 21 patients (26.3%) and fall from height in 15 patients (18.8%) (Table 2).

Table 1: Age and gender distribution of study patients.

Parameters		N	%
Age group (years)	≤10	1	1.25
	11-20	7	8.75
	21-30	10	12.5
	31-40	20	25
	41-50	17	21.25
	51-60	14	17.5
	61-70	10	12.5
	71-80	1	1.25
Mean ± SD (range)=41.8±12.17			
Gender	Male	55	68.7
	Female	25	31.3

In our study number of VAC dressing changes ranged from 1 to 6 with majority of the patients i.e., 37 (46.3%) required two VAC dressing changes before definitive wound coverage (Table 3). The most common post VAC procedure in our study was STSG done in 63 patients (78.8%) followed by various local, regional or distant flap covers in 9 patients (11.3%). Most common complication in study patients while being on VAC therapy was feeling of pain, which was present in 24 patients (30%). In study, max number of patients i.e., 37 (46.25%) had to spend between 500 to 1000 INR (mean 11.76 USD), with only 6/80 patients (7.5%) requiring to spend >1500 INR (Table 3). Maximum no. of patients 56/80 (70%) in study had a hospital stay of between 10-19 days followed 16 patients (20%) with 20-29 days.

Table 2: Distribution of patients as per site and etiology of wound.

Distribution of patients		No. of patients	Percentage (%)
Site of wound	Leg	20	25.0
	Thigh	14	17.5
	Foot	10	12.5
	Back	6	7.5
	Knee	5	6.3
	Buttock	4	5.0
	Ankle	3	3.8
	Forearm	3	3.8
	Forearm with hand	2	2.5
	Sacral region	2	2.5
	Scrotum	2	2.5
	Heel	2	2.5
	Thigh with leg	2	2.5
	Hand	1	1.3
	Hip	1	1.3
	Perineum	1	1.3
	Scalp	1	1.3
	Breast	1	1.3
Etiology of wound	Road traffic accident	24	30.0
	Necrotizing fasciitis	21	26.3
	Fall from height	15	18.8
	Decubitus ulcer	8	10.0
	Burn	4	5.0
	Diabetic foot ulcer	4	5.0
	Post incision drainage abscess wounds	1	1.3
	Animal attack	1	1.3
	Paraplegic pressure ulcer	1	1.3
	Trophic ulcer	1	1.3

Table 3: Distribution of patients as per number of VAC dressings, post VAC procedure, complications, cost of dressing and hospital stay.

Distribution of patients		No. of patients	Percentage (%)
No. of VAC dressing changes	1	9	11.3
	2	37	46.3
	3	20	25.0
	4	7	8.8
	5	4	5.0
	6	3	3.8
Post VAC procedure	STSG	63	78.8
	Flap cover	9	11.3
	Secondary suturing	5	6.3
	Secondary healing	3	3.8
Complications	Pain	24	30
	Hypoalbuminemia	6	7.5
	Surrounding skin maceration	3	3.8
	Flap site infection	1	1.3
	Nil	46	57.5
Cost of dressing (INR)	≤500	23	28.75
	501-1000	37	46.25
	1001-1500	14	17.5
	>1500	6	7.5
Hospital stays in days	0-9	2	2.5
	10-19	56	70

Continued.

Distribution of patients		No. of patients	Percentage (%)
	20-29	16	20
	30-39	6	7.5
	40-49	0	0

DISCUSSION

VAC is a novel technique that has revolutionized the management of the wounds in the past 15 to 20 years. There is significant amount of literature regarding the efficacy, its safety, speed of action and cost effectiveness in management of complex wounds.[5,13]

In our study maximum numbers of patients were in the age group of 31-40 years (25%). Our finding was in concordance with those noted in their study by Zargar et al.[14] The likely reason for this could be because of the fact that patients in this peak and productive age of life are most active and outdoors and are more at risk of sustaining accidental injuries and trauma. In our study 55 patients were males (68.75%) and 25 were females (31.25%) with a male to female ratio of 2.2:1. The general agreement in the literature regarding male predominance has been reported in majority of previous studies which is consistent with our study.[15,16] This again is related to the tendency of males choosing more active and vigorous outdoor activities and hence more chance of injuries. Most of the wounds in our study patients were located over lower limbs (70%). Leg was the most common site followed by thigh and foot. Our observations are at par with those observed in their study by Mullner et al and DeFranzo et al were where the wounds on the extremities was the most common site, managed by VAC therapy.[17,18] Our study presented with complex soft tissue wounds that were sustained by a variety of modes; with road traffic accidents (RTA) being the commonest mode present in 24/80 patients (30%). Similar observations were noted by Dedmond et al and DeFranzo in their studies where they found RTA was major mode of injury and the resultant cause of wounds on which VAC therapy was applied.[16,19] Conventionally managed, these wounds would take a long time till they would become amenable for the definitive procedures like STSG, flap cover, secondary suturing etc. With the use of VAC therapy, these wounds became fit for definitive closure much earlier, thus decreasing the hospital stay and morbidity and improving cost effectiveness of treatment. All the patients in the study were subjected to VAC therapy after proper wound preparation. The average number of VAC dressings was in a range of 3.5. Similar results were noted in their studies by Shilt et al and Madhav et al.[15,20] While reviewing the literature, regarding the average number of VAC dressings needed before the definitive wound coverage it was seen that some of the studies have shown lesser number of VAC dressings needed for the wound coverage by granulation tissue.[19,21] while as other have shown a higher number of VAC dressings needed for the same purpose.[17] This is explained by variation in the different clinicopathological factors involved in the wound healing including infection, underlying comorbidities, technique of VAC used, pressure in the VAC used, difference in wound size etc., when compared with conventional methods. After the VAC therapy, in our study, 63/80 patients (78.8%) were managed by STSG, 9 (11.3%) patients were managed by some form of flap coverage, 5 patients (6.3%) were managed by secondary suturing, 3 (3.8) patients healed by secondary intention. Our findings were at par with those of Mullner et al and Madhav et al where 80% and 87% of their patients were managed by STSG respectively.[17,20] No significant major complications were encountered during VAC therapy of the study subjects in our series of patients. Pain, especially at the time of dressing change was experienced by about 30% of the patients. The pain used to remain for about 10 to 20 minutes post dressing change and was managed by oral/IV analgesics. Surrounding skin maceration was seen in 3.8% patients. 7.5% developed hypoalbuminemia and these patients had large sized wounds, poor nutritional status and decreased oral intake. 1.3% patients had flap site infection. 57.5% patients did well and were discharged without any in-hospital issue. Minor episodes of bleeding from wound were seen in few patients. Bleeding was mainly attributed to the adhesion of the foam to wound bed and was significantly decreased when the wound was irrigated by normal saline via suction tubing before removal of foam dressing. Similar minor complications like pain, bleeding, surrounding skin maceration were seen in their studies by Haroon and Madhav.[14,19]

The average total cost of the VAC therapy in our study was 863.13 (±399.82) Indian rupees which amount to a mean of about 11.76 USD. This cost applies only to VAC therapy excluding hospital charges. In a study reported by Kolios et al the average total cost of VAC therapy was 3266 USD.[22] Similarly, in another study reported by Chaput et al average cost of VAC therapy was 15 USD per day.[23] A European study on the cost of treatment of VAC therapy of wounds reported an average cost of VAC therapy to be 24 Euros per day.[24] The disparity in the average cost in our study as compared to other studies is explained by the fact that the classical commercially available VAC machine (Kinnester) and accessories cost about 3-4 lacs. While as we used indigenously devised VAC which comprised of wall mounted suction apparatus, sterilized foam, chest tube drains and simple connecting tubing and sterile adhesive drape which significantly reduced the cost of the VAC therapy.

Besides there were no costs of application and maintenance as all manpower and most of the material is free in government hospitals like ours. The patient had to buy only the adhesive drape used in the VAC therapy. Rest of the things including the foam, drainage tubing and manpower was provided by the hospital free of cost to the patient. We used a wall mounted vacuum creating apparatus for study, which is also property of hospital. Hence in our setup, VAC therapy was very much cost effective as compared to other mentioned studied.

The mean duration of hospital stay for a patient was 17 (±6.5) days, with an average of 22 days. Our results were consistent with those of Kilios et al however they are at variance with those of Chupat et al where mean hospital stay of 16 days duration was reported.[22,23]

CONCLUSION

To summarize, VAC therapy seems to have revolutionary potential in the management of the difficult to treat wounds as far as its safety, speed and cost effectiveness is considered, especially when supervised by professional wound care specialists.

Average time taken for the wounds to become fit for definitive wound closure methods is much less than the average time taken for similar wounds managed by conventional ways.

The cost of customized VAC therapy using wall mounted suction apparatus available in hospital wards is much lower and affordable to patients in a setup like ours. Thus, we conclude that this study supports the efficacy and cost effectiveness of the customized indigenous VAC therapy as a novel technique in management of complex wounds, suited for poor income countries like ours.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Burke JF, Yannas IV, Quinby WC Jr, Bondoc CC, Jung WK. Successful use of a physiologically acceptable artificial skin in treatment of extensive burn injury. Ann Surg. 1981;194(4):413-28.
2. Parenteau N. Skin: the first tissue-engineered products. Sci Am. 1999;280(4):83-4.
3. O'Connor NE, Mulliken JB, Banks-Schlegel S, Kehinde O, Green H. Grafting of burns with cultured epithelium prepared from autologous epidermal cells. Lancet 1981;1(8211):75-8.
4. Fleischman W, Strecker W, Bombelli M, Kinzl L. Vacuum sealing as treatment of soft tissue damage in open fractures. Un-fallchirurg. 1993;96(9):488-92.
5. Argenta LC, Morykwas MJ. Vacuum assisted closure; a new method for wound control and treatment: clinical experience. Ann Plast Surg. 1997;38(6):563-77.
6. Morykwas MJ, Arjenta LC. Non-surgical modalities to enhance healing and care of soft tissue wounds. J South Orthop Assoc. 1997;6(4):279-88.
7. Morykwas MJ, Arjenta LC, Shelton Brown EI, Mcguirt W. Vacuum-assisted closure: a new method for wound control and treatment. Ann Plast Surg. 1997;38(6):553-62.
8. Fabain TS, Kaufman HJ, Lett ED, Thomas JB, Rawl DK, Lewis PL et al. The evaluation of sub atmospheric pressure and hyperbaric oxygen in ischemic full-thickness wound healing. Am Surg. 2000;66(12):1136-43.
9. 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. 2005;28:211-7 .
10. Moues CM, Vos MC, Van Den Bemd GCM, Stijnen T, Hovius SE. Bacterial load in relation to VAC wound therapy: A prospective randomized trial. Wound Repair Regen. 2004;12(1):11-7.
11. Shi B, Chen SZ, Zhang P, Li JQ. Effects of VAC on the expression of MMP-1, 2, 13 in human granulation wound. Zhonghua Zheng Xing Wai Ke Za Zhi. 2003;19(4):279-81.
12. Vuerstaek JD, Vainas T, Thissen CA, Van der Kley J, Nelemans P, Neumann MHA et al. State of art treatment of chronic leg ulcers: A randomized controlled trial comparing Vacuum-assisted closure with modern wound dressings. J Vasc Surg. 2006;44(5):1029-37.
13. Lambert KV, Hayes P, McCarthy M. Vacuum assisted closure: a review of development and current applications. Eur J Endovasc Surg. 2005;29(3):219-26.
14. Zargar HR, Mohsin M, Baba PUF, Wani HA, Iqbal S, Zaroo MI et al. Negative pressure wound therapy: Eleven-year experience in a tertiary care hospital. Int J Res Med Sci. 2017:5(5):1835-42.
15. Shilt JS, Yoder JS, Manuck TA, Jacks L, Rushing J, Smith BP. Role of VAC in treatment of pediatric lawn mower injuries. J Pediatr Orthop. 2004;24(5):482-7.
16. Dedmond BT, Kortesis B, Punger K, Simpson J, Argenta J, Kulp B et al. Sub-atmospheric pressure dressings in the temporary treatment of soft tissue injuries associated with type 3 open tibial shaft fractures in children. J Pediatr Orthop. 2006;26(6):728-32.
17. Mullner T, Mrkonjic L, Kwasny O, Vecsie V. The use of negative pressure to promote healing of soft tissue defects. Br. J. plast surg. 1997;50(3):194-9.
18. DeFranzo AJ, Marks MW, Argenta LC, Genecov DG. Vacuum assisted closure for treatment of degloving injuries. Plast Reconstr Surg. 1999;104(7):2145-8.
19. DeFranzo AJ, Argenta LC, Marks MW, Molnar JA. The use of vacuum assisted closure therapy for the

treatment of lower extremity wounds with exposed bones. J plast Reconstr surg. 2001;108(5):1184-91.
20. Madhav V, Babu BC. Vacuum assisted therapy in treatment of soft tissue injuries associated with gustilo Anderson compound grade 3B fractures. Int J Orthop Sci. 2016;2(2):101-4.
21. Song DH, Wu LC, Lohman RF, Gottlieb JL, Franczyk M. Vacuum-assisted closure for the treatment of sternal wounds: the bridge between debridement and definitive closure. Plast Reconstr Surg. 2003;111(1):92-7.
22. Kolios L, Kolios G, Beyersdorff M, Dumont C, Stromps J, Freytag Set al. Cost analysis of topical negative pressure therapy for traumatic acquired wounds. Ger Med Sci. 2010;8:Doc13.
23. Chaput B, Garrido I, Eburdery H, Grollreau JL, Chavoin JP. Low-cost negative-pressure wound therapy using wall vacuum: A 15 Dollar by Day Alternative. Plast Reconstr Surg Glob Open. 2015;3(6):e418.
24. Braakenburg A, Obdeijn MC, Feitz R, Van Rooij IA, Van Griethuysen AJ, Klinkenbijl JH. The clinical efficacy and cost effectiveness of vacuum-assisted closure technique in the management of acute and chronic wounds: a randomized controlled trial. Plast Reconstr Surg. 2006;118(2):390-7.

Cite this article as: Mir MA, Wani T, Khan TS, Shah SMA, Kumar R, Naikoo ZA, Bhat BA. Customized vacuum assisted closure therapy of wounds as a simple and cost-effective technique of wound closure-a prospective observational study from underdeveloped world. Int J Res Med Sci 2021;9:1329-34.