

**A Prospective Study: To Evaluate the Efficacy of VAC in the Management of Wounds with Exposed Bones/Tendons in Children****Puja Priyadarshini**

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Received: 03-07-2023 Revised: 11-08-2023 / Accepted: 20-09-2023

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Conflict of interest: Nil

**Abstract****Aim:** The aim of the present study was to evaluate the efficacy of VAC in the management of wounds with exposed bones/tendons in children.**Methods:** The present prospective observational study was conducted in the Department of Plastic Surgery for the period of one year. VAC dressing was used in 50 patients.**Results:** Out of 50 patients, 34 were male and 16 were females with the patients had a mean age of 8.4 years. Road traffic accident was the most common mode of injury (56%), with most of the wounds located over extremities. The most common site of wounds in our study was legs, presents in 12 patients (24%) followed by thigh in 8 patients (16%) and foot in 6 patients (12%) making the lower limb the most common area of the body involved. In our study road traffic accidents (RTA) comprised the most common mode of injury present in 16 patients (32%) followed by necrotizing fasciitis in 12 patients (24%) and fall from height in 10 patients (20%). In our study number of VAC dressing changes ranged from 1 to 6 with majority of the patients i.e., 24 (48%) required two VAC dressing changes before definitive wound coverage. The most common post VAC procedure in our study was STSG done in 40 patients (80%) followed by various local, regional or distant flap covers in 5 patients (10%). Most common complication in study patients while being on VAC therapy was feeling of pain, which was present in 24 patients (30%). Maximum no. of patients 34 (68%) in study had a hospital stay of between 10- 19 days followed 11 patients (22%) with 20-29 days.**Conclusion:** In conclusion, our study supports the VAC therapy as a relatively atraumatic technique to manage soft tissue defects in complex extremity wounds in pediatric patients. The VAC therapy proved to be an effective, safe, cost effective, easy to learn, and simple technique that managed the complex soft tissue defects in children without the morbidity and complications associated with flap procedures.**Keywords:** Vacuum-Assisted Closure, Exposed Bone, Expose Tendon.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**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]

Vacuum-assisted closure (VAC) was described by Morykwas et al in 1997. [7,8] VAC therapy is considered a novel method of accelerating wound healing. The vacuum system helps in the debridement of dead and necrotic tissues and decreases wound edema through application of negative pressure. Its macro deformational forces cause strain over wound edges, causing wound margin to contract and drawing the wound edges together, resulting in decrease of wound size. [9] It promotes tissue perfusion and provides a moist, closed wound healing environment. The micro deformation mechanism of the VAC system promotes healthy granulation tissue formation. [10] The improvements in the local wound environment

accelerate wound healing and prepare the wound for definite wound coverage. [11]

Wound healing is a complex and dynamic process that includes an immediate sequence of cell migration leading to repair and closure. This sequence begins with removal of debris, control of infection, clearance of inflammation, angiogenesis, deposition of granulation tissue, contraction, remodeling of the connective tissue matrix, and maturation. When wound fails to undergo this sequence of events, a chronic open wound without anatomical or functional integrity results. [12] High-energy open fractures require both skeletal stability and adequate soft tissue coverage. In such injuries, debridement of all nonviable tissue can produce significant soft tissue defects precluding healing through primary closures, delayed primary closures, or secondary intention. [13] Various surgical methods have been developed to obtain coverage in these difficult situations. These include skin grafts, local rotation flaps, and myocutaneous or fasciocutaneous tissue transfers. Although skin grafts are readily obtainable, they are dependent on the vascularity of its recipient bed and may be contraindicated when exposed bone, cartilage, tendons, or surgical implants exist. [14] In such situation, a local rotation flap may be needed. When the soft tissue defect prevents local coverage [15], free tissue transfers are usually required, but the transfer may produce donor site morbidity and require late revisions due to the size of the muscle flap. [16]

The aim of the present study was to evaluate the efficacy of VAC in the management of wounds with exposed bones/tendons in children.

### Materials and Methods

The present prospective observational study was conducted in the Department of Plastic Surgery Nalanda Medical College and Hospital, Patna, Bihar, India for the period of one year. VAC dressing was used in 50 patients.

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

**Table 1: Gender distribution and mode of injury**

Gender	N%
Male	34 (68)
Female	16 (32)
Mode of injury	
Road traffic accidents	28 (56)
Fall from height	12 (24)
Others	10 (20)

Out of 50 patients, 34 were male and 16 were females with the patients had a mean age of 8.4 years. Road traffic accident was the most common mode of injury (56%), with most of the wounds located over extremities.

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

Distribution of patients		No. of patients	Percentage (%)
	Leg	12	24
	Thigh	8	16
	Foot	6	12
	Back	4	8
	Knee	3	5
	Buttock	2	4
	Ankle	2	4
	Forearm	2	4
	Forearm with hand	2	4
<b>Site of wound</b>	Sacral region	1	2
	Scrotum	1	2
	Heel	1	2
	Thigh with leg	1	2
	Hand	1	2
	Hip	1	2
	Perineum	1	2
	Scalp	1	2
	Breast	1	2
	Road traffic accident	16	32
	Necrotizing fasciitis	12	24
	Fall from height	10	20
	Decubitus ulcer	4	8
	Burn	2	4
<b>Etiology of wound</b>	Diabetic foot ulcer	2	4
	Post incision drainage abscess wounds	1	2
	Animal attack	1	2
	Paraplegic pressure ulcer	1	2
	Trophic ulcer	1	2

The most common site of wounds in our study was legs, presents in 12 patients (24%) followed by thigh in 8 patients (16%) and foot in 6 patients (12%) making the lower limb the most common area of the body involved. In our study road traffic accidents (RTA) comprised the most common mode of injury present in 16 patients (32%) followed by necrotizing fasciitis in 12 patients (24%) and fall from height in 10 patients (20%).

**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 (%)
	1	6	12
	2	24	48
	3	12	24
<b>No. of VAC dressing changes</b>	4	4	8
	5	2	4
	6	2	4
	STSG	40	80
	Flap cover	5	10
<b>Post VAC procedure</b>	Secondary suturing	3	6
	Secondary healing	2	4
	Pain	14	28
	Hypoalbuminemia	3	6
<b>Complications</b>	Surrounding skin maceration	2	4
	Flap site infection	1	2
<b>Hospital stays in days</b>	0-9	1	2
	10-19	34	68

	20-29	11	22
	30-39	4	8
	40-49	0	0

In our study number of VAC dressing changes ranged from 1 to 6 with majority of the patients i.e., 24 (48%) required two VAC dressing changes before definitive wound coverage. The most common post VAC procedure in our study was STSG done in 40 patients (80%) followed by various local, regional or distant flap covers in 5 patients (10%). Most common complication in study patients while being on VAC therapy was feeling of pain, which was present in 24 patients (30%). Maximum no. of patients 34 (68%) in study had a hospital stay of between 10- 19 days followed 11 patients (22%) with 20-29 days.

### Discussion

The management of complex soft tissue defects with exposed bones/tendons is always a challenging task for the surgeon and the problem becomes more pronounced when it comes to the management of these wounds in children. The immature age, tragic incident of trauma, long hospital stay, and complex and invasive treatment required, all add to the psychological breakdown of the child. The overall situation demands a treatment modality that is effective, safe, relatively atraumatic, and less invasive so as to provide minimal discomfort, anxiety, and pain to the child while offering a standard care for the wound. [17]

Out of 50 patients, 34 were male and 16 were females with the patients had a mean age of 8.4 years. The general agreement in the literature regarding male predominance has been reported in majority of previous studies which is consistent with our study. [18,19] Road traffic accident was the most common mode of injury (56%), with most of the wounds located over extremities. 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. [19,20]

The most common site of wounds in our study was legs, presents in 12 patients (24%) followed by thigh in 8 patients (16%) and foot in 6 patients (12%) making the lower limb the most common area of the body involved. Our observations are at par with those observed in their study by Mullner et al and DeFranzo et al where the wounds on the extremities was the most common site, managed by VAC therapy. [21,22] Thomas first postulated that application of mechanical stress would result in angiogenesis and tissue growth. Unlike sutures or tension devices, the VAC can exert a uniform force at each individual point on the edge of the wound drawing it toward the centre

of the defect by mechanically stretching the cells when negative pressure is applied. [23] This allows the VAC to move distensible soft tissue, similar to expanders, towards the centre of the wound, thereby decreasing the actual size of the wound. [24]

In our study road traffic accidents (RTA) comprised the most common mode of injury present in 16 patients (32%) followed by necrotizing fasciitis in 12 patients (24%) and fall from height in 10 patients (20%). In our study number of VAC dressing changes ranged from 1 to 6 with majority of the patients i.e., 24 (48%) required two VAC dressing changes before definitive wound coverage. The most common post VAC procedure in our study was STSG done in 40 patients (80%) followed by various local, regional or distant flap covers in 5 patients (10%). Most common complication in study patients while being on VAC therapy was feeling of pain, which was present in 24 patients (30%). Maximum no. of patients 34 (68%) in study had a hospital stay of between 10- 19 days followed 11 patients (22%) with 20-29 days. 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. [21,25]

The highly significant increase in the rate of granulation tissue formation of sub atmospheric pressure-treated wound is postulated to be due to transmission of the uniformly applied force to the tissues on the periphery of the wound. These forces both recruit tissues through viscoelastic flow and promote granulation tissue formation. Currently, the Ilizarov technique and soft tissue expanders both apply mechanical stress to tissues to increase mitotic rates. [26,27] Standard wound dressings adhere to devitalized tissue and within four to six hours the gauze can be removed, along with the tissue, as a form of mechanical debridement. This method of wound care has been criticized for removing viable tissue as well as nonviable tissue and being traumatic to granulation tissue and to new epithelial cells. [28]

### Conclusion

In conclusion, our study supports the VAC therapy as a relatively atraumatic technique to manage soft tissue defects in complex extremity wounds in pediatric patients. The VAC therapy proved to be an effective, safe, cost effective, easy to learn, and simple technique that managed the complex soft tissue defects in children without the morbidity and complications associated with flap procedures.

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