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CLINICAL STUDY

Vacuum assisted closure in vascular surgery

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Abstract: *Background:* Vacuum assisted closure (VAC – therapy) is a well established method in nearly all surgical disciplines. The aim is to present the efficiency of vacuum assisted closure in the treatment of acute and chronic wounds in patients admitted in the department of vascular surgery.
Methods: Within the year 2008 there were 59 patients (44 men, 15 women) treated with VAC therapy in our Department of Vascular surgery (Landshut, Germany). VAC was used 22x (37.28 %) in therapy of ulcus cruris (venous, arterial, mixed genesis), 15x (25.42 %) in patients with diabetic foot syndrome, 12x (20.33 %) in secondary healing wounds and infected wounds, 5x (8.47 %) in wounds after several injuries and soft skin tissue infections and 5x (8.47 %) in wound infections connected with vascular graft infections after vascular revascularization.
Results: VAC therapy seems to be very effective in the management of patients with venous ulcers, especially after a proper surgical treatment (100 %), patients with soft skin tissue infections (100 %) and secondary healing wounds (100 %) especially in combination with MESH – Grafting. In patients with diabetic foot syndrome (80 %) and peripheral arterial occlusive disease (72.7 %), an evaluation of peripheral blood perfusion and revascularization prior to VAC therapy is often necessary. Although VAC was used 5x in the therapy of infected vascular grafts, successful preservation of infected graft material was observed in only one case (infection of PTFE femoro-popliteal bypass graft).
Conclusion: Vacuum assisted closure in vascular surgery proved to be simple and efficient method in therapy of acute and chronic wounds. The efficiency of VAC systems in therapy of infected graft material after revascularization needs further studies *(Tab. 3, Ref. 10).* Full Text in free PDF *www.bmj.sk.*
Key words: acute and chronic wounds, negative pressure wound therapy, vacuum assisted closure, peripheral arterial occlusive disease, infected graft material.

Negative pressure wound therapy (NPWT – Vacuum assisted closure) has been well known for decades. Fleischman was probably the first man to report about NPWT. In his publication – Vacuum sealing as treatment of soft tissue damage in open fractures (1993) – he presents his experiences with the treatment of open fractures with Vacuum sealing (1). The results of his work have led to the conclusion that NPWT enables an efficient cleaning and conditioning of the wound, with marked proliferation of granulation tissue (1, 2). According to further excellent results in therapy of chronic wounds first commercial vacuum system for NPWT was implemented in USA in 1995. This new vacuum system enabled the use of computer controlled intermittent or continual sub – atmospheric pressure in surgical practice for the first time.

In the last years NPWT has become an accepted therapy of acute and chronic wounds nearly in all surgical disciplines. How is NPWT functioning? According to several works of some authors (Morykwas, Fabian) vacuum assisted closure enables wet therapy, drainage of excessive tissue fluid, eliminates tissue swelling, decreases the total volume of the wound, and supports granulation (3, 4, 5). The quintessence of vacuum assisted closure (VAC system) is shown in Table 1.

VAC and VISTA are the two most popular systems for NPWT currently used in Europe in the therapy of acute or chronic wounds. VAC system is well known and is preferred also in our department of vascular surgery. The main parts of this system involve a portable pump and a foam. The vacuum pump provides a microprocessor controlled negative pressure. According to the wound conditions, foams made of polyurethane (PU), polivinylalcohol (PVA) or polyurethane with silver (PUS) are used (5, 6). The usage of VAC therapy in vascular surgery is documented in Table 2.

Material

Within the year 2008 there were 59 patients (44 men, 15 women) treated with vacuum therapy in our Department of Vascular Surgery (Landshut, Germany) (Tab. 3). VAC system was used 22x (37.28 %) in therapy of ulcus cruris (venous, arterial, mixed genesis), 15x (25.42 %) in patients with diabetic foot syndrome, 12x (20.33 %) in secondary healing wounds and infected wounds after operations, 5x (8.47 %) in wounds after soft skin

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Tab. 1. How is VAC system functioning?

Vacuum therapy enables wet therapy	Wet therapy enables proper hydration of tissue cells
Vacuum therapy enables drainage of excessive tissue fluid Vacuum therapy eliminates tissue swelling	Continual drainage and elimination of swelling decreases bacterial contamination, bacterial migration, decreases inflammation and increases tissue blood perfusion (125 mmHg negative pressure)
Vacuum therapy supports granulation and decreases the total wound volume	Negative pressure in combination with mechanical irritation lead to increased proliferation of granulation tissue (48 h of continual VAC increases cell mitosis and decreases the inactive period of cell division)

Tab. 2. NPWT in vascular surgery.

1) Ulcus cruris, Chronic venous Insufficiency
2) MESH – Grafting, free muscle Flap transplantations
3) Diabetic foot Syndrome (in combination with revascularisation)
4) Peripheral arterial occlusive dissease (mostly in combination with revascularisation)
5) Secondary healing and infected wounds after several vascular operations/interventions, Amputations, or combined traumatologic and vascular operations
6) Lymphatic fistulas and soft skin tissue infections (Erysipel)
7) Prevention and therapy of infections after revascularisation (…infection of vascular grafts… etc.)

tissue infections and trauma, 5x (8.47 %) in vascular graft infections. In all patients portable pumps and mostly polyurethane foams were used. The value of negative pressure as well as the pump containers were regularly controlled. The polyurethane foam was changed regularly in 3–4 day intervals.

Results

According to our experiences the highest efficiency of Vacuum assisted closure was observed in patients with venous ulcers (especially after proper surgical treatment – 100 %), patients with ulcers after soft skin tissue infections (100 %) and secondary healing wounds after trauma or successful vascular revascularization (100 %).

In all cases, where VAC therapy was combined with mesh grafting, excellent results were observed. All patients underwent a Doppler-Duplex examination. In all the cases mentioned no signs of severe ischaemia were noticed.

In 11 cases peripheral defects were connected with peripheral arterial occlusive disease (PAOD, arterial ulcus). The efficiency of VAC therapy in PAOD (8/11, 72 %) was strictly dependant on peripheral blood perfusion. In all cases where a successful revascularization (4x bypass, 4x PTA) could have been performed followed by VAC therapy rapid healing was observed. In four cases peripheral revascularization in patients with PAOD Fontaine IV was not possible. In this group of patients in only one case VAC therapy led to successful healing of a distal crural ulcer. In 2 patients VAC therapy caused progressive worsening of local ischaemic changes with necrosis leading to a below knee amputation.

The efficiency of VAC therapy in patients with diabetic foot syndrome was observed in 12 cases (80 %). In this group of patients the ulcus or peripheral defect (toe, heel, forefoot, etc…) were mostly associated with neuropathy. Necrectomy or minor amputation followed by vacuum therapy were mostly performed. According to angiographic findings some kind of peripheral revascularization (mostly PTA) could have been performed in 11 cases, but was necessary only in 9 (8x PTA, 1x crural bypass). In two cases VAC therapy proved to be efficient enough, so that revascularization did not seem inevitable. The worst results in this group of patients were observed in those with severe necrosis of the heel combined with osteomyelitis (3x). In two cases a below knee amputation must have been performed. VAC therapy with mesh grafting was in the group of patients with diabetic foot syndrome performed 3 times. In all three cases a complete healing of the wound could be observed.

In the therapy of infected wounds connected with infection of prosthetic graft material vacuum assisted closure was used 5x. In 4 cases a removal of prosthetic material and subsequent reconstruction with a vein were performed. The infection of the wounds after femoro-popliteal bypass grafting was observed 2x. In one case, with proved infection of prosthetic graft, VAC therapy led to graft preservation and healing of the wound (Infection of the PTFE prosthesis without direct anastomosis involvement). In the second case of infected femoro-popliteal bypass, removal of prosthetic material was conducted. Although VAC therapy led to secondary suture and healing of all the wounds in femoral region a progression of ischaemic changes on the periphery of the lower limb (peripheral Bypass with vein material could not be performed) resulted in a below knee amputation. In this group only in one case a polyurethane – silver foam was used.

Discussion

In our opinion VAC system is highly efficient in wounds with sufficient blood perfusion of the injured tissue. In cases of se-

Tab. 3. Vacuum assisted closure in the Department of Vascular Surgery Landshut - Achdorf (2008).

Indication	N/Succes	Gender (M/W)	Foam (PU, PVA, PUS)	AT of VAC therapy (days)	NP (mmHg)	Operation Varicosis – V Revascularisation – R Amputation – A	mesh -grafting
Ulcus cruris (UC):	22/19	M					
– venous	6/6	W	PU20	14±6.27	125/150	V4	2
– arterial/venous	5/5		PVA2		100/125	V/R 2/1	3
– arterial	11/8				50-125	R/A 7/2	5
Diabetic foot syndrom (DFS)	15/12	M W	PU15				
– plantar, crural	3/2			21±11.3	100/125	R1	1
– heel	3/1			1	100/125	R/A 1/2	2
– DV	4/4				100/125	A/R 3/3	
– DI	5/5				100/125	A/R 4/4	
Secondary healing after operation	12/10	M W	PU12	17±7.31			
– secondary heeling wounds after amputation	4/2				75/100		
– secondary heeling wounds after revascularisation	6/6				125		
– compartment sy.	2/2				125		1
SSTI, Trauma	5/5	M					
– crural infection erysipel, abscess	2/2,	W	PU4 PVA1	12±10.8 3	100		1
– infected haematoma,	2/2				125		
– crural ulcus (secondary to injury or fracture)	1/1				125		
Infections after vascular reconstructions, vascular graft infections	5/5	M W	PU4 PUS 1	32±15.9			
– infection in the groin (Patchplasty of femoral bifurc	2/2				100/125	Replacement with GSV 2x	
–infection of the PTFE prosthesis after (fem-pop PTFE bypass, interpositum)	3/3				125	Removement of the prosthesis 2x (A – 1x)	

verely reduced blood perfusion (critical ischaemia – PAOD) Doppler-duplex ultrasound and conventional or MRI – angiography with subsequent revascularization must be considered. In cases of peripheral blood pressure below 30mmHg NPWT without revascularization could even worsen local ischaemia. On one hand vacuum system enables drainage of the wound (reducing tissue swelling and increasing tissue perfusion), but on the other hand by exerting pressure in an ischaemic area VAC system can cause collapse of the capillary perfusion thereby supporting ischaemia. The negative pressure used in our group of patients after revascularization was 100 or 125 mmHg, however, in patients without proper revascularization (was not possible) it was only 50 mmHg. Despite this low pressure a progression of ischaemic changes could have been observed leading to amputation.

Perfusion is not the only factor playing a role in the NPWT. Many times skin conditions in the surrounding area made NPWT impossible. Such conditions can be found in elderly patients or in patients with venous ulcers due to chronic venous insufficiency. In these patients the skin becomes too thin so that it can easily become injured in the course of foil removement (6). This can also happen if the foam has to be changed very often, mostly because of severely infected wound with extensive secretion (6, 7). Worsened skin conditions may also appear when the VAC system does not work properly and prevents proper drainage of the wound. Extensive secretion in these cases causes erosion of the surrounding skin. In most cases VAC system is usually replaced by conventional wound dressings.

In the therapy of peripheral ulcers a combination of wound conditioning with the VAC system and mesh grafting with vacuum assisted closure was shown to be also efficient. Due to a smooth pressure of the VAC foam a better contact of mesh graft and wound could be achieved. This was needed mostly in narrow

areas (forefoot). According to our experiences correct filling of the entire wound with the PU – foam (without free spaces) and tightness of the whole system contribute to the efficiency of VAC system (6). That is why in active patients daily check-ups of the tightness are needed. If the drainage of the wound could not be ensured (mostly because of a leak) a change of the VAC system with a new foil sealing should be done. In our opinion the tightness of the whole system could be ensured also in the toe area. This is especially useful after peripheral necrectomy or open toe amputations in patients with peripheral neuropathy in diabetic foot syndrome. Tightness of the system in such cases may be achieved by special adhesive strips.

In case of wound infection with massive debris or necrosis surgical debridement and necrectomy prior to VAC therapy seem to be necessary (8). The evaluation of local bacterial status and parallel antibiotic therapy are convenient in many cases (8, 9). Regular changes of the VAC foam mainly in highly infected wounds or in wounds with bone exposure are recommended.

Over the past period the most interesting issue on vacuum therapy seems to be the efficiency in patients with infected prosthetic graft material. In these patients successful therapy of graft infection could often lead not only to graft but also limb and life preservation (10). In the year 2008 5 patients with prosthetic graft infections were treated in our department. In one case, where a local infection of a PTFE prosthesis near distal anastomosis of a femoro-popliteal PI bypass was found (Streptococcus epidermidis) a local use of VAC therapy enabled graft preservation. In cases of infected dacron Patch after femoral pathplasty (2x), a replacement of the infected material with a vein and subsequent vacuum therapy were performed. In one case a muscle flap was used to protect the patch from a direct contact with the polyurethan-silver foam. In one case an infection of a PTFE prosthesis after iliac aneurysm repair resulted in retroperitoneal abscess. Removal of the PTFE prosthesis with VAC system from an extraperitoneal approach and subsequent cross-over bypass with a silver coated ring prosthesis was performed. After 60 days of almost continual vacuum and antibiotic therapy no bacterial contamination was documented. A secondary suture could have been performed? An abdominal CT scan showed no signs of infection after 6 and 9 months.

Conclusion

VAC system in vascular surgery proved to be a simple and efficient method in the therapy of acute and chronic wounds. According to our experiences limitations of this system include peripheral blood perfusion, skin status, compliance and activity of patients. A combination of vacuum assisted closure therapy and mesh-grafting brings excellent results in many patients with peripheral ulcers. The efficiency of VAC systems in the prevention and therapy of infected prosthetic graft material seems to be possible in some cases, nevertheless further studies are needed.

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