



Use of Vacuum-Assisted Closure (VAC) along with Integra® Wound Matrix after a transtatarsal amputation (TMA) following an accident caused by a mower – a case study

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Abstract

Introduction. Vacuum-Assisted Closure (VAC) is one of the modern-treatment methods for closing wounds using Integra® Wound Matrix, a matrix of 2 mm bovine collagen with a silicone layer, supporting collagen deposition and revascularisation.

Case Report. The case is described of a patient who underwent a VAC therapy combined with Integra® Wound Matrix after a transtatarsal amputation (TMA) with degloved forefoot. The wound was inflicted by a mower, which makes it especially challenging because of the high risk of infection. Another challenge was the location of the amputation – transtatarsal (TM), which is often considered for below-knee amputation (BKA). The successful treatment process that prioritised maintaining the foot is described, a promising treatment sequence for extensive and complex traumatic wounds causing TMA. The potential benefits and risks of implementing collagen matrix and VAC system are discussed.

Key words

amputation, accident, VAC, collagen matrix, integra, mower, NPTW

INTRODUCTION

Traumatic wounds of the lower limbs with a destruction of soft tissue and a fracture remain a serious therapeutic problem. One of the biggest challenges is the transtatarsal amputation, which is related to a high risk of subsequent higher-level amputation. Considering the possibility of severe complications, such as infection, necrosis, and impaired wound healing, the treatment of such wounds is a complex, long-term process, requiring an interdisciplinary approach combining orthopaedics, general surgery, rehabilitation, and an anti-infective treatment [1–5].

Studies show that implementing the VAC leads to the removal of contamination and removal of exudation, reduction of microbiome colonization, and reduction of swelling. Moreover, it precipitates the formation of a normal granulation tissue [6–10]. The use of Integra, in the case of skin defects, as a base for skin grafting ensures elasticity, flexibility, and softness of the reconstruction area [11, 12]. Considering all the above, the duration of the healing process

can be shortened, and the percentage of repercussions which may occur during the treatment process diminished [6, 8, 9, 13].

CASE REPORT

A 2-year-old girl was urgently admitted to the Paediatric Orthopedics Clinic due to an accident with a mower. As a result, the patient experienced transtatarsal amputation and a fracture of the distal metaphysis of the right tibia (Fig. 1). The patient had no comorbidities. A severed foot fragment of the right foot which included 3 toes and a fragment of the metatarsus, was brought in an ice bag but was not suitable for replantation. X-ray revealed fractures of the distal metaphysis of tibia and fibula, amputation of metatarsals – II and V in the proximal part, III and IV in the distal part of the right foot, fractures of the shafts of metatarsals III and IV, and the proximal metaphyseal of 1st metatarsal of the right foot, and amputation of toe I in the metatarsophalangeal joint. The hallux of the right foot was dislocated, a skin strip with torn tendons, except for the hallucis flexor and hallucis extensor, remained attached (Fig. 2). The hallux was not

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Figure 1. Preoperative X-ray of the right lower limb. The image reveals fractures of the distal metaphysis of the tibia and fibula, along with extensive traumatic amputation of the metatarsals II–V and the first toe at the metatarsophalangeal joint



Figure 2. Clinical presentation of the right foot upon admission. Severe degloving injury (scalping) of the metatarsus reaching the level of the Chopart joint, following a lawnmower accident

replanted due to the small diameter of the blood vessels. The metatarsus were scalped to the level of the Chopart joint, which created an extremely challenging case, as transmetatarsal amputations themselves are considered at high risk of subsequent amputations.

An operation was performed the same day, surgical debridement of the wound carried out, and a closed reduction of the fracture of the distal metaphysis of the right tibia performed with percutaneous Kirschner wires fixation. After the surgical debridement of the stump and rinsing it with 0.9% NaCl saline, Integra® Wound Matrix (Fig. 3) was placed directly on the remains of the foot. The VAC system was then applied at the negative pressure of 100mmHg. Moreover, perforations were cut in the Integra® Wound Matrix for better access to take smears, and to allow better under-pressure penetration. Subsequently, a plaster splint was placed on the limb.

To prevent possible infection, antibiotic therapy was

implemented empirically – cefuroxime (3×33 mg/kg and metronidazole 3×7.5 mg/kg). Anti-inflammatory treatment was implemented for 7 days due to the 39.0°C fever and elevated CRP. Cold compresses were additionally recommended along with elevation of the affected limb.

The treatment summary and dynamics of changes in inflammatory parameters are presented in Table 1.

During the month of VAC therapy, the dressings were changed 5 times under general anaesthesia, at intervals of several days (range 4–7 days) on the 5th, 11th, 15th, 19th, and 26th day. VAC system replacement intervals were based on a clinical protocol for assessing wound healing under general anaesthesia in children, and monitoring of Integra® matrix integration. Antibiotic changes did not dictate VAC intervals, clinical signs of infection and matrix adherence were the primary drivers.

Additionally, swabs from the wound were taken during every procedure of dressing change from the window in

Table 1. Summary of the treatment process, including changes of inflammatory parameters, antibiotic therapy and surgical procedures

Day of treatment	Procedure	WBC N (5–12 ty	Neu (no/%) N (1.5–7/30–50%	CRP N (0–0.5 mg/dl)	Fever	Swab	Bacterial growth	Antibiotic
1	Debridement + Integra® + NPWT	14.85	9.58/64,5	11.7	yes			Cefuroxime 3×33 mg/kg + Metronidazol 3×7.5 mg/kg
3	-	13.9	6.51/56	5.98	yes	-	-	continued
5	Debridement + Dressing change	10.6	5.21/49,2	0.53	yes	E.cloacae	numerous	continued
11	Dressing change	8.1	3.71/45,8	0.06	no	E.cloacae	reduced	Change to Cotrimoxazol/Trimetoprim $2 \times 30 + 6$ mg/kg – allergic reaction after 1 st dose; changed to Cefotaxime 3×50 mg/kg
15	Dressing change	8.73	3.45/39,4	<0.03	no	E.cloacae	single	continued
19	Dressing change				no	E.cloacae	single	continued
26	Skin graft+NPWT	5.27	1.77/33,6	<0.03	no	-	-	discontinued
33	NPWT removal	-	-	-	no	-	-	-



Figure 3. Intraoperative application of Integra® Wound Matrix. The 2mm bovine collagen and silicone bilayer matrix was placed directly onto the debrided stump to promote revascularization and provide a foundation for subsequent grafting



Figure 4. Postoperative view after autogenous split-thickness skin graft (STSG). The graft was fixed with surgical staplers over the integrated collagen matrix and protected by a silicone dressing and the Vacuum-Assisted Closure (VAC) system



Figure 5. Clinical outcome at the 6-year follow-up. The stump is fully healed with no additional deformities. The patient exhibits a symmetrical gait and normal physical development for her age

Integra® perforation performed during the index surgery. Antibigrams showed the presence of an *Enterobacter Cloacae* Complex. The antibiotic therapy was continued with a change to cotrimoxazole according to the antibiogram; this was later changed to cefotaxime as an allergic reaction to cotrimoxazole occurred. The smears of anaerobic bacteria were negative. The smears of *Enterobacter cloacae* complex showed an unspecified amount, moderately numerous in quantity, and a singular quantity, indicating a gradual and

steady decrease in bacteria. The parameters of wound healing were defined: colour change of the Integra matrix (from pink to vanilla – a sign of readiness for transplantation), granulation tissue quality, and the final functional result after 6 years

On the 26th day, when the Integra® changed colour from pink to vanilla, it was removed. An autogenous skin transplant from the front of the right thigh to the right foot was performed using an electric dermatome. The autogenous split-thickness skin transplant was fixed directly on the new Integra® Wound Matrix with staplers. A silicone dressing was placed on the skin graft layer to avoid direct contact of the skin transplant with the VAC system, which was then placed on top. After the skin transplant, the VAC was kept in place for 5 days (Fig. 4). Also on day 26, Kirschner wires were removed.

The plaster splint was taken off (Fig.5) and the patient discharged home in good general condition with recommendations for general care.

On the 6-year follow-up, the stump has healed, and no additional deformities of the stump were observed. The length of the limbs is equal, the gait symmetrical, without any limping. The dorsiflexion of both feet is comparable. The patient does not use any prosthesis for everyday life, and development is within the normal developmental age range; moreover, the patient attends school without any limitations.

DISCUSSION

Post-traumatic wounds remain a serious medical problem, considering their complexity from the onset of patient care, with a long-term therapeutic process associated with many possible complications [4].

Vacuum-Assisted Closure, which stands for Negative

Pressure Wound Therapy, employs negative pressure directly onto the wound by a closed dressing system. It allows an effective management of exudation, reduction of the wound surface, and diminishes the risk of wound dehiscence [7, 13]. Vana et al. described in their study the benefits of combining wound matrix and Negative Pressure Therapy. It showed improvement of quality and mobility of the skin with graft contraction in all patients [14].

The application of the VAC system has been described in numerous scientific studies. Analyzing the cases, it is noticeable that VAC improves healing, limits infections, and precipitates wounds for further treatment, such as skin autografts or surgical occlusions [6–10, 15, 16]. Studies also show a decreased mortality rate for patients treated with VAC [9, 16]. Furthermore, on implementing this method for very demanding treatments, such as pressure ulcers and diabetic foot, which show its high clinical potential [7, 10, 17, 18]. The benefits of VAC result from acceleration of healing, owing to improvement of perfusion and stimulation of proper granulation [6–9, 13, 19]. Additionally, application of Integra® Matrix Wound adds to the positive effect on wound healing [14, 20]. Integra creates a foundation for skin regeneration, stimulating the skin and reducing scarring, just like the VAC system, it additionally stimulates granulation [11, 12]. Comparative studies show that VAC shortens the time of treatment and hospitalization, along with the prevalence of infections, compared to the traditional dressing [8, 13]. Reduced time of hospitalization translates into a positive effect on the patients' mental state, which adds to the comfort of treatment [9].

Change of the VAC takes place every 5–7 days, which is less frequently than changing a standard dressing. It contributes to the positive impact of the patients' well-being by causing less pain and stress related to the change of dressing [9, 13, 21].

Due to the VAC constant drainage of effusion, it decreases the risk of infections, leading to a reduction of antibiotic therapy and the period of time it takes if any antibiotics are applied [8]. Infections noted during the use of Integra® Wound Matrix, however, are not uncommon [22, 23]. Despite the multiple advantages of the VAC system, it is also not without its limitations. One of them is the sealing of the VAC system and drainage failure. Among the complications are bleeding, pain, limitation of mobility, wound infection, skin abrasion, and allergic reaction to the glue [24]. Even though it decreases the overall costs of hospitalization, the equipment itself is expensive, thus not every hospital may be equipped, especially in small towns and underdeveloped countries, [13, 17, 18, 25]. Moreover, VAC cannot be implemented in the case of local presence of neoplastic cells, dry necrosis, untreated osteitis or osteomyelitis, or glue allergy in general [7, 26].

In the presented case, it was decided to perform a transmetatarsal amputation. An amputation that preserves the forefoot is favoured over an amputation at the Chopart joint that would be non-functional. The amputee stump in the Chopart joint is very short, which means it does not provide good leverage for transferring forces during walking; it is more difficult to adjust and stabilize the prosthesis, and it lacks support points and surfaces for distributing pressure [27].

Transmetatarsal amputations are challenging because they cause altered foot biomechanics, deformities, and difficulties with healing and prosthetic fitting. Although they allow for the preservation of part of the foot, they often require intensive rehabilitation, realignment, and specialized

orthopaedic care.

Another important aspect is careful observation carried out both by the patient and the doctor to reduce the repercussions of possible unsealing or infections in general. What makes this particular case special is the successful transmetatarsal amputation. These amputations are at high risk of re-operation, which often culminates in a below-knee amputation. One of the risk factors that may have an impact on foot amputations is that of infection [1–3]. It is worth noting that the described wound was a very demanding case, considering the location itself and the garden tool that inflicted it, causing a high risk of severe infections and subsequent higher-level amputation. The decision was therefore made to use the VAC system, which prevents such infections.

The replantation is performed very rarely because they are not essential for walking, and patients usually function very well without them. Furthermore, the procedure is difficult, lengthy, and ineffective.

CONCLUSIONS

Implementation of the Vacuum-Assisted Dressing together with wound matrix in the treatment of post-traumatic wounds can be an efficient treatment method. It allows faster wound healing through granulation, which may reduce the hospitalization time, enhance patients' mental comfort, and accelerate rehabilitation. The VAC system and wound matrix are beneficial, especially for very severe and complex cases. Nevertheless, it is worth noting that the medical state of a patient should be carefully assessed before starting the Negative Pressure Wound Therapy, considering the contraindications.

In the presented case, despite the unsealing, a reduction of the bacterial colony was noted; therefore the overall evaluation of the VAC and collagen matrix treatment remained positive.

To sum up, the Vacuum-Assisted Closure combined with the wound matrix is a valuable treatment method which is especially worth implementing in complicated cases, as the numerous benefits may overcome the potential risks if monitored carefully.

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