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CASE REPORT

Degloving lower leg injury – the importance of additional treatment: negative pressure and hyperbaric oxygen therapy

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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ABSTRACT:

Degloving injury poses a severe therapeutic challenge concerning both trauma and plastic surgery. The injury involves separation of skin and subcutaneous tissue from fascia and muscles. Treatment is often long-lasting and brings unsatisfying results due to the extent of damage, risk of infection and massive blood loss.

In this article, we present the management and therapeutic outcomes of a patient admitted due to the degloving injury of the lower extremity caused by workplace accident. We described the complexity of treatment including surgical intervention as well as additional treatment, which combined brought good esthetic outcome.

INTRODUCTION

Degloving injuries are caused by shearing forces acting parallel to the tissue resulting in displacement of the superficial tissue layers. An injury to lower extremities causes tearing off of the skin and subcutaneous tissue from underlying fascia and muscles. Soft tissue injury can be accompanied by extensive damage to the deep structures of the limb. In addition to the detachment of skin and subcutaneous fat, muscle, vessel and nerve damage is often observed together with bone fractures, which requires an interdisciplinary approach covering orthopedic, vascular, general and plastic surgery [1]. Those complications significantly worsen the prognosis.

Such injuries usually involve lower extremities and torso and are caused by traffic accidents, workplace injuries and improper use of agricultural machinery [2].

The extent of injury and high risk of infection can cause life-threatening complications. The risk of therapeutic failure is increased in the presence of concomitant diseases and advanced age. An important poor prognostic risk factor is concurrent long bone fracture [3].

In patients with degloving injuries, a wide range of conservative and surgical approaches may be applied. The easiest technique used in such patients is reattachment of the skin flap. This approach often results in partial or total necrosis of the reattached tissues, especially in the case of circular wounds. According to the literature, flap reattachment and pressure bandage do not yield satisfactory results, especially in the case of circular wounds [4].

Another surgical technique applied in patients sustaining a degloving injury is an autologous skin graft [4]. Directly after the injury and surgical debridement of the donor and recipient site, the graft may be harvested from the flap and implanted into the wound [3,5,6].

In selected cases, particularly of head trauma, it is possible to use the detached tissues as a flap supplied by occipital and/or temporal vessels, which can be reattached using microsurgical techniques [7]. Such procedures can be applied in the absence of significant skin damage and in case of preserved good quality of blood vessels in both the flap and the recipient site. To assess flap vitality and quality of perforators, Doppler ultrasound or fluorescein staining can be implemented [8].

Degloving injury of the lower limb is associated with severe tissue damage and high risk of complications. Hematoma formation, wound infection and later phlegmon can lead to developing sepsis. That complication along with deep venous thrombosis can be life-threatening. Therefore, proper management includes anticoagulation and definitive narrow-spectrum antimicrobial therapy. Early local complications include: bleeding, which can often require blood transfusion, ischemia of distal portions of lower extremities, local infection, while late local complications affect function and esthetics – limb deformation, scarring, sensory loss and lymphedema [2].

Vacuum- assisted closure therapy (VAC™) is helpful in debridement of the wound, especially in the case of coexisting bone fracture [9]. The use of VAC™ as a complementary treatment in combined therapy seems to be an effective method of limiting the extent of tissue damage [10,11,12]. It is believed that negative pressure treatment acts by increasing the cell division rate, facilitating angiogenesis and local production of growth factors [13]. Also, by alleviating edema, VAC™ can increase perfusion at the microcirculatory level [11].

Another method promoting wound healing is hyperbaric oxygen therapy. The use of high concentration oxygen inhibits inflammation, shows an analgesic and bactericidal effect and facilitates creation of new blood vessels (angiogenesis). Furthermore, oxygen facilitates production of collagen, elastin and extracellular matrix by fibroblasts [14, 15]. Wound infection can result in tissue hypoxia despite normal blood supply. Coexisting infection and hypo-

xia inhibit repair mechanisms. Hyperbaric oxygen therapy results in increased oxygen partial pressure in ischemic tissues and as a consequence improves leukocyte function, causes suppression of exotoxin production and acts synergically with antibiotics. Additionally, it has an antimicrobial effect against anaerobes [16]. Combined surgical intervention with hyperbaric oxygen therapy seems to enable faster recovery and return to daily activities.

The complexity of managing degloving injuries to lower extremities consists of restoration of integumentary continuity, obtaining optimal functional and esthetic effect enabling movement as well as addressing psychological issues.

In this article, we present the management and therapeutic outcomes of a patient admitted due to degloving injury of the lower extremity caused by a workplace accident. We describe the complex management involving surgical intervention as well as additional treatment, which combined brought a good esthetic result.

CASE REPORT

A 40-year-old female patient called M.B. was hit by a forklift truck at her workplace and as a result sustained the following injuries: head trauma (subcutaneous hematoma in the occipital region), degloving injury of the left lower leg (circular sliding off of skin flap from the knee to the ankle level), left ankle and foot injury (subluxation of the talocrural joint, lateral malleolus fracture, oblique fracture of the distal portion of the 5th metatarsal, dislocation of the 5th metatatsophalangeal joint).

Initially, the patient was admitted to the Department of Trauma and Orthopedic Surgery. During her stay, she underwent surgical intervention – the following were reattached: posterior tibial artery, medial head of the gastrocnemius muscle (the flap was circularly reattached in the popliteal region) and the reduction of the lateral malleolus fracture was performed. Next, the patient was transferred after 24 hours to the Department of Plastic, Reconstructive and Esthetic Surgery for further treatment.

At the admission to the Department, venous congestion within the left lower leg was noted (leakage of dark blood after skin puncture, dark color and slight edema of the flap) as well as single small epithelial blisters on the dorsal surface of the left foot filled with serous fluid. On the medial surface of the left lower limb, preserved vitality of the flap was observed (light red bleeding after puncturing) (Fig. 1).

Considering light red bleeding after flap puncture, surgical intervention was abandoned. The patient initially received conservative treatment (Lioton [heparin] gel dressings, thorough moisturizing using Nitrofurazone ointment, Urgo dressing for the ruptured blisters, antibiotics, anticoagulation prophylaxis, left lower limb elevation). Furthermore, treatment in the Hyperbaric Therapy Center was initiated (15 sessions).

Computed tomography angiography of the left limb was performed. The occlusion of the anastomosis of the posterior tibial artery was noted (the artery was non-occluded proximally, filling by collateral circulation distally). The patient was consulted by the vascular surgeon, who confirmed the vitality of the flap and suggested continuing conservative treatment and removing drainage (the drain was removed on the 6th day after admission).

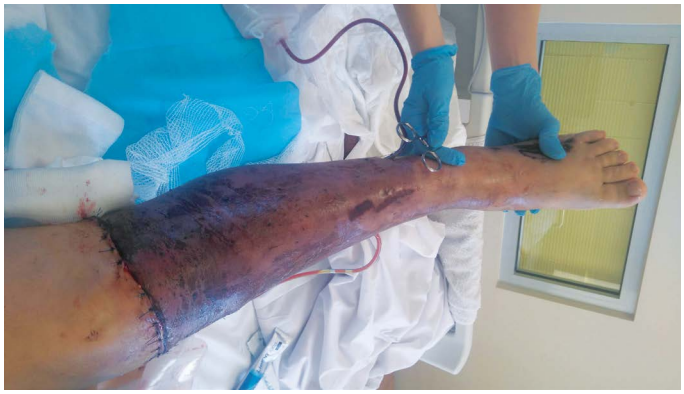

Fig. 1. Degloving injury of lower leg – day 1 in the Department of Plastic, Reconstructive and Esthetic Surgery

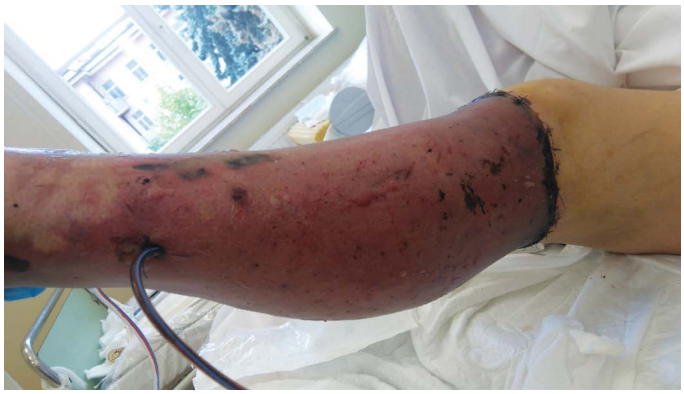

Fig. 2. Lower leg on day 5

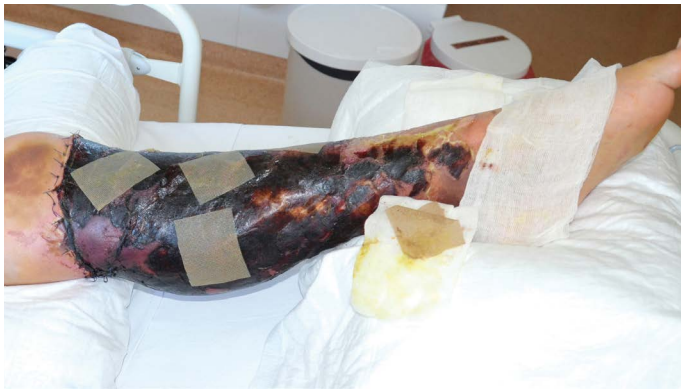

Fig. 3. Flap necrosis – day 12

During the next days, a substantial improvement of the left lower leg was noted. Initially, we observed the reduction of edema and local lightening of the skin. The skin color transitioned from dark violet to cherry red (Fig. 2). Gradually single epithelial blisters developed filled with serous fluid on the dorsal surface of the foot and on the crus with tendency to rupture. Later, we observed severe epithelial necrolysis without serous or purulent discharge.

On day 12, the appearance of the left lower leg suddenly worsened and the diagnosis of necrosis of the major part of the flap was made (Fig. 3). Necrectomy was performed (the entire flap was removed), the adipose tissue was cut off tangentially until superficial

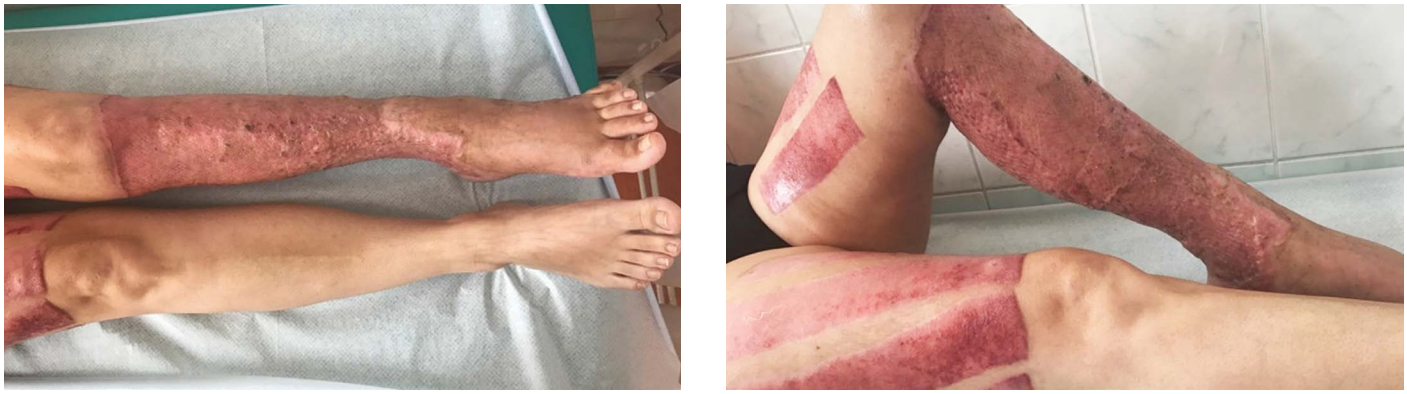

Fig. 4a and b. Lower leg after skin graft healing – day 52 since skin grafting

focal bleeding. Also, pus collection was observed in the posterior and distal part of the crus. The dressing with 0.25% AgNO3 solution was applied. Cultures revealed Pseudomonas aeruginosa growth. Narrow-spectrum antibiotic was administered (Augmentin [amoxicillin + clavulanic acid] 1.5 g b.i.d. i.v. was discontinued and Ceftazidime 2 g t.i.d. i.v. was introduced). Hyperbaric oxygen therapy was continued (additional 21 sessions were performed, for a total of 36 sessions).

During her later stay, the patient underwent wound debridement and necrectomy 4 times under general anesthesia. 0.25% AgNO3 dressings were continued. Smear and cultures were positive for Pseudomonas aeruginosa resistant to Ceftazidime. The antibiotic was changed for Tobramycin (80ml/240mg once a day, i.v.). On day 28, VAC™ dressing was applied (75 mmHg, continuous mode) and 350 ml of serosanguineous fluid was drained (maximum drainage was observed on day 2 – ca. 800 ml of serosanguineous fluid).

After 3 days, the wound was debrided and the dressing was changed. The entire surface of the wound was covered with granulomatous tissue. On the following two days, 500 ml of serosanguineous fluid were drained daily. Wound debridement was repeated once again. The defect was covered with mesh split-thickness skin grafts (1 : 1.5 and 1:3) harvested from the left and right thighs, and the VAC™ dressing was applied again (intermittent mode, 100 mmHg). Approximately 250 ml of serosanguineous fluid were drained daily. One week later, the dressing was removed and the grafts were healing properly. The VAC™ dressing was applied once again (continuous mode, 75 mmHg). Mean drainage was about 200 ml of serosanguineous fluid per day. One week later, another intervention was performed – the remaining defects on the left leg were covered with split-thickness skin grafts harvested from the left thigh. Later, normal healing of skin grafts was observed and the remaining single areas were covered by exuberant granulation tissue. The following dressings were applied: Inadine, Bactigras, silicone mesh, Aquacell, Nitrofurazone ointment.

In summary, the patient was discharged home on day 59 in good general and local condition for later out-patient observation. The patient was also referred to the orthopedist to continue treatment and to the Department of Medical Rehabilitation for Adults for further rehabilitation.

During her stay, the patients required transfusion of 8 units of packed red blood cells and 3 units of fresh frozen plasma. Nine interventions under general anesthesia were performed. Negative pressure therapy was applied using the VAC™ system. She was consulted a couple of times by the orthopedist and vascular surgeon. Total therapy in the Hyperbaric Therapy Center included 36 sessions. Finally, a satisfactory esthetic outcome was achieved (Fig. 4a and b).

After 9 weeks since the accident, the permanent coverage of skin defect of the left lower leg and foot was achieved. The skin graft healed completely. For single areas with granulomatous tissue, 20% AgNO3 solution was applied. Due to long-term immobilization and the decision by the orthopedist and rehabilitation specialists to postpone rehabilitation until complete healing, contraction of the triceps surae muscle (gastrocnemius and soleus muscles) and the Achilles tendon entailed, resulting in clubfoot-like positioning. After discharge, the patient was referred for further orthopedic treatment and rehabilitation.

DISCUSSION

The consequences of degloving injuries are severe and often managed improperly. It usually affects males (91%) aged 30.5 ± 12.8 years. The most common locations are lower extremities (44%), head and neck (37.3%) and back (13.5%) [5,19]. Algorithms of managing degloving injuries differ between different centers. Therapeutic success indicators are ambiguous, and some protocols are controversial [3].

Closure of the defect can be a serious issue in the case of extensive circular degloving wounds. The management depends on many factors, including age, concomitant diseases, extent of injury and degree of soft tissue damage. The decision regarding therapeutic strategy is based on clinical presentation and the experience of the medical team [2]. An experienced team of physicians and nurses plays a vital role. Also, the access to the hyperbaric chamber and the opportunity to apply negative pressure therapy are crucial.

In this case, we assume that an important role in facilitating the healing process was played by the negative pressure therapy, which promotes formation of granulation tissue, skin graft healing and eliminates the risk of Pseudomonas aeruginosa infection.

The most common form of using negative pressure therapy (VAC™) is the continuous mode. The intermittent mode is less painful compared to the continuous mode as it provides smooth shift between two levels of negative pressure. Experimental data show that the

intermittent mode (0 to -80 mmHg) results in greater granulation tissue than the continuous mode (-80 mmHg). Probably it is due to repeated mechanical stimulation leading to faster remodeling of the granulation tissue and improved blood flow within the wound margins [9,10,12,13]. It allowed to obtain a layer of granulation tissue, which in turn made it possible to implant skin grafts at the level of the unaffected skin. Satisfactory esthetic outcome resulted from the equal level of the unaffected skin and the skin grafts.

Hou et al. appreciated the role of negative pressure therapy in graft healing and preventing infection and emphasized the importance of even pressing down of the skin graft to the entire wound surface. Preventing graft detachment, additional fixing to counteract any displacement together with exudate drainage play an important role in faster wound healing [17].

An important issue in the described patient was the wound infection by Pseudomonas aeruginosa. It is the most common (58.1%) etiological factor of wound infection followed by Staphylococcus aureus, Enterobacterriacae, Enterococci and Acinetobacter species. Unal et al. in a study on 132 patients found that such an infection leads to graft loss in 23.7% of cases. Moreover, Pseudomonas aeruginosa infection is characterized by a rapid course and a higher reoperation rate [20]. Høgsberg et al. reported skin graft healing rate of only 33% in the presence of Pseudomonas aeruginosa compared to 77% for sterile ground. [21]. Our experience suggests that additional treatment (negative pressure, hyperbaric oxygen therapy) and definitive narrow-spectrum antibiotics make it possible to achieve full skin graft healing in spite of Pseudomonas aeruginosa infection.

Yan et al. in cooperation with Kudsk et al. emphasized the role of skin graft harvesting from the detached skin immediately after the injury [3,18]. They proved that full- and split-thickness grafting brings optimal results. They discourage from attempting primary flap reattachment. However, the authors do not give any information regarding the safe time interval between the injury and graft harvesting from the flap. In our case, the flap was primarily reattached to healthy tissues in the orthopedic ward. After admission to the Department of Plastic Surgery (24 hours since the injury) and during the first 12 days, it showed sing of vitality. Finally, due to necrosis it was removed and skin grafts from other areas were implanted. This case shows how difficult is the decision on primary removal of the detached tissues, especially when the patient is managed in a different ward immediately after the injury.

CONCLUSIONS

1. Negative pressure therapy applied for circular wounds of the lower leg in both continuous and intermittent modes with pressure ranging up to -100 mmHg is safe.

2. Combined treatment (negative pressure, hyperbaric oxygen therapy) allows to achieve skin graft healing in spite of Pseudomonas aeruginosa infection.

REFERENCES:

1. McGrouther D.A., Sully L.: Degloving injuries of the limbs: long-term review and management based on whole-body fluorescence. Br. J. Plast. Surg., 1980; 33: 9–24
2. Wójcicki P., Wojtkiewicz W., Drozdowski P.: Severe lower extremities degloving injuries--medical problems and treatment results. Pol. Przegl. Chir., 2011; 83: 276-282
3. Yan H., Gao W., Li Z., Wang C., Liu S., Zhang F., Fan C.: The management of degloving injury of lower extremities: technical refinement and classification. J. Trauma Acute Care. Surg., 2013; 74: 604-610
4. Arnez Z. et al.: Classification of soft-tissue degloving in limb trauma. J. Plast. Reconstr. Aesthet. Surg., 2010; 63: 1865-1869
5. Minten L., Hovius S.E., Gilbert P.M.: Degloving injuries. A retrospective study at the University Hospital Rotterdam. Acta Chir. Belg., 1992; 92: 209-212
6. Khan U., Ho K., Deva A.: Exchanging split-skin grafts to reduce donor morbidity in limited pretibial degloving injuries. Plast. Reconstr. Surg., 2004; 113: 1523-1525
7. Waikakul S.: Revascularisation of degloving injuries of the limbs. Injury, 1997; 28: 271-274
8. Hidalgo D.: Lower extremity avulsion injuries. Clin. Plast. Surg., 1986; 13: 701-710
9. DeFranzo A.J., Argenta L.C., Marks M.W., et al.: The use of vacuum-assisted closure therapy for the treatment of lower-extremity wounds with exposed bone. Plast. Reconstr. Surg., 2001; 108: 1184-1191
10. Meara J.G., Guo L., Smith J.D., et al.: Vacuum-assisted closure in the treatment of degloving injuries. Ann. Plast. Surg., 1999; 42: 589-594
11. Wong L.K., Nesbit R.D., Turner L.A., Sargent L.A.: Management of a circumferential lower extremity degloving injury with the use of vacuum-assisted closure. South. Med. J., 2006; 99: 628-630
12. Dini M., Quercioli F., Mori A., Romano G.F., Lee A.Q., Agostini T.: Vacuum-assisted closure, dermal regeneration template and degloved cryopreserved skin as useful tools in subtotal degloving of the lower limb. Injury, 2012; 43: 957-959
13. Saxena V., Hwang C.W., Huang S., et al.: Vacuum-assisted closure: micro-deformations of wounds and cell proliferation. Plast. Reconstr. Surg., 2004; 114: 1086-1096
14. de Smet G.H.J., Kroese L.F., Menon A.G., Jeekel J., van Pelt A.W.J., Kleinrensink G.J., Lange J.F.: Oxygen therapies and their effects on wound healing. Wound Repair Regen., 2017 Aug 7
15. Jones C.M., Rothermel A.T., Mackay D.R.: Evidence-Based Medicine: Wound Management. Plast. Reconstr. Surg., 2017; 140: 201-216
16. Fourth Consensus Conference of the European Committee on Hyperbaric Medicine, London, December 4-5 1998. Hyperbaric oxygen in the management of foot lesions in diabetic patients, Diabetes, Nutrition & Metabolism -Clinical & Experimental, 1999; 12: 47-48
17. Hou Z., Irgit K., Strohecker K.A., Matzako M.E., Wingert N.C., DeSantis J.G., Smith W.R.: Delayed flap reconstruction with vacuum-assisted closure management of the open IIIB tibial fracture. J. Trauma, 2011; 71: 1705-1708
18. Kudsk K.A., Sheldon G.F., Walton R.L.: Degloving injuries of the extremities and torso. J. Trauma, 1981; 21: 835-839
19. Hakim S., Ahmed K., El-Menyar A., Jabbour G., Peralta R., Nabir S., Mekkodathil A., Abdelrahman H., Al-Hassani A., Al-Thani H.: Patterns and management of degloving injuries: a single national level 1 trauma centerexperience. World J. Emerg. Surg., 2016; 11: 35
20. Unal S., Ersoz G., Demirkan F., Arslan E., Tütüncü N., Sari A.: Analysis of skin-graft loss due to infection: infection-related graft loss. Ann. Plast. Surg., 2005; 55: 102-106
21. Høgsberg T., Bjarnsholt T., Thomsen J.S., Kirketerp-Møller K.: Success rate of split-thickness skin grafting of chronic venous leg ulcers depends on the presence of Pseudomonas aeruginosa: a retrospective study. PLoS One, 2011; 6: e20492

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