

Original article

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Failures and complications in treatment of patients with degloving injury of integumentary tissues

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Annotation

The complexity of the condition, lack of clear routes for patients with degloving injury of integumentary tissues, inadequate and untimely diagnosis, lack of clinical guidelines and a paucity of literature lead to a great number of failures and complications in treatment of the cohort of patients. The **objective of the study** was to analyze failures and complications encountered in treatment of patients with degloving injury of integumentary tissues, and identify ways for the prevention. **Material and methods** Medical records of 40 patients with degloving injury of integumentary tissues were retrospectively reviewed. The patients treated in trauma departments and the Burn Center in Chelyabinsk between 2008 and 2014 were divided into two groups according to the time of admission to the burn center. The first group of patients was hospitalized within 6 days of injury and over. The second group of patients was admitted to the combustiology department in the first 5 days of injury. **Results** Failures in diagnosis and treatment were mostly observed in patients who were admitted for treatment after 5 days of injury. Most common complications included necrosis of integumentary tissues, infected wounds, necrosis of skin autografts. **Discussion** Most of the complications seen in patients with extensive degloving injury of integumentary tissues resulted from organizational, diagnostic, therapeutic, strategical and technical failures, and several adverse events were associated with the severity and extent of the involved tissues. **Conclusion** A number of recommendations have been offered for prevention of failures and complications in treatment of the cohort of patients.

Keywords: degloving injury of integumentary tissues, extensive wound, failure of wound treatment, skin plastic surgery, plastic surgery, patient route

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INTRODUCTION

Degloving injuries of integumentary tissues are associated with impact of high intensity force with tangential vectors to the surface of the skin causing compression, tension, twisting and friction. This force causes separation of the skin and subcutaneous tissue from the superficial fascia damaging muscles, bones and neurovascular formations in some cases [1–7]. When patients with multiple, concomitant or combined injury are admitted to the emergency units insufficient attention is paid to the damaged integumentary tissues. Injury to the skin covers does not lead to life-threatening conditions in the early period. Currently many techniques were offered for the treatment of injured from this cohort [8–15]. However, underestimation of necrotic changes in degloving tissues or incorrect surgical tactics is pregnant with the development of endogenous intoxication and fatal purulent septic complications leading to lethal outcomes.

Some foreign literature sources indicate that in addition to the trauma surgeon and emergency physician, in the medical care of these patients the plastic surgeon

may be of use in assessing the viable integumentary tissues, definition of the reconstructive treatment stages for skin defects, choosing the type of plastic surgery and performing it as early as possible in the optimal time [16–18]. On the territory of the Russian Federation, the relevant skills are included in the professional standard of doctors in several specialties: trauma and orthopaedic surgeon, general surgeon and plastic surgeon [19–21]. Plastic surgeons are extremely rarely involved in the treatment of patients with degloving injuries of integumentary tissues in budgetary medical institutions and most often, the treatment is carried out by combustiologists surgeons as specialists in closing extensive wound defects [22]. The complexity of the pathology and the lack of clear routes for patients with this diagnosis lead to a large number of failures and complications [1, 2, 23], which defines the relevance of the work objective.

The **objective of the study** was to analyze failures and complications encountered in treatment of patients with degloving injury of integumentary tissues and identify ways for the prevention.

MATERIALS AND METHODS

The work is based on the experience of the patients management in regional trauma departments and Municipal

Hospitals (mainly the Burn Center No 6) in Chelyabinsk and Chelyabinsk region between 2008 and 2014.

40 patients including 21 female (52,5 %) and 19 males (47,5 %) with different mechanism of injury (Table 1) were followed up.

According to our classification [24] we produced the rating of the patients basing on the depth of the tissues injury (Table 2).

Table 1
Distribution of patients according to the mechanism of injury

Mechanism of injury	Number of patients	
	abs.	%
collision with a car wheel	17	42.5
getting a limb into moving mechanism (dough mixer, rollers, conveyor belt)	13	32.5
drawing on asphalt	2	5
limb compression followed with traction	3	7.5
car collision accident	3	7.5
contusion	1	2.5
dog bite	1	2.5
Totally	40	100

Table 2
Distribution of patients according to the depth of tissues injury

Type of injury	Number of patients	
	abs.	%
Injury at the level of the skin and subcutaneous fat cellular tissue	4	10
Injury at the level of the skin, subcutaneous fat cellular tissue and superficial fascia	8	20
Injury at the level of integumentary tissues and crush of the muscles	7	17.5
Deglaving integumentary tissues combined with injury of vascular nerve formations and bone tissue (fracture, bone defect)	21	52.5
Totally	40	100

All patients were divided into two groups according to the time of admission to the Burn Center.

The first group of patients (20 persons) was hospitalized after injury to the Trauma Departments of the nearest general hospitals. After stabilization of the condition and consultation with combustiologist the patient was transferred to the Burn Center of Chelyabinsk city not later than within 6 days of injury.

The second group of patients was admitted to the combustiology department in the first 5 days of injury. Some of them were delivered by ambulance teams from the site of accident to the emergency department of the general municipal hospital No. 6 in Chelyabinsk, that had a Burn Center in addition to the Trauma Department. The rest of the patients were transferred from other medical institutions after examination or correspondening consultation with combustiologist.

There were two lethal cases among the retrospectively viewed case reports of the first group. These patients were initially admitted to the trauma departments of municipal hospitals in Chelyabinsk, where they underwent long treatment. On the background of the development of purulent septic complications, the patients were transferred from the trauma departments to the infection departments and then to the intensive care units of the same hospitals. Combustiologist was invited to one female patient in 1.5 months after the injury. The second victim was examined by combustiologist few hours before her death (on the 18th day after the injury). The lethal outcome in both cases occurred on the background of multiple organ failure and septic condition. No operations were performed by the combustiologist in both cases due to the extremely severe condition of the patients.

6 patients of the second group were admitted in a shock condition. The severe condition was caused by trauma, concomitant injuries and post-traumatic and hemorrhagic shock. The patient were in the intensive care unit from the moment of admission under the joint supervision of trauma surgeon and combustiologists.

Patients of the first group on admission to the Burn center after treatment in other medical institutions had necrotic wounds related to the second and third grades of the infection process. Therefore, the debridement of wounds by various methods and repeated surgical treatment followed by surgical coverage of wound defects by various methods of autodermoplasty were carried out.

In the second group of patients, the treatment process was more intensive, allowing to avoid the development of infection process in damaged tissues.

Treatment of patients in both groups resulted in complete restoration of integumentary tissues. We analyzed the timing of the final recovery of wound healing, the number of operations and dressings, and the duration of inpatient treatment.

The work was performed in accordance with the ethical standards of the Declaration of Helsinki of the World Medical Association "Ethical principles for conducting scientific medical research involving humans" as amended in 2013 and "Rules of Clinical Practice in the Russian Federation", approved by order of the Ministry of Health of the Russian Federation, dated June 19, 2003 No. 266. Patients signed an informed consent for the surgical intervention and the publication of the data obtained without identification of the individual.

Statistical processing of quantitative data was done in Microsoft Excel electronic Tables using the Attestat software (version 9.3.1, developer Gaydyshev I.P., Certificate of Rospatent No. 2002611109). Due to the small sample size ($n < 30$), the Mann-Whitney test was used to evaluate the hypothesis on the difference between the compared groups.

RESULTS

After analyzing the medical records of the injured, it was revealed that diagnostic and treatment failures occurred in most patients of the first group (Table 3). Medical and tactical errors were observed in all patients of the first group, while in 11 patients few treatment simultaneous errors were noted during their stay in the trauma hospital.

All above failures contributed to complications in

the postoperative period in all patients of the first group (Table 4).

There were no organizational, diagnostic and therapeutic failures in the second group. Nevertheless, in five patients during the treatment marginal necrosis of skin grafts was noted. There was no infection. This complication did not affect good treatment outcome.

Table 3

Distribution of the first group of the patients according to the category of failures (n = 20)

Failure type	Number of patients	
	abs.	%
Diagnostic failures	11	55
Improper definition of degloving tissues area	4	20
Wrong (biased) evaluation of viability of damaged integumentary tissues	5	25
Non-diagnosed closed degloving injury of integumentary tissues in case of open wound	2	10
Medical and tactical failures	20	100
The attempt for primary suturing of the wound with tension of its edges, that led to aggravation of tissue ischemia and skin necrosis on the background of traumatic swelling	5	25
No adequate dynamic control of the local process leading to the development of necrotic and infection complications	6	30
No active and/or passive wound drainage (leading to accumulation of wound discharge and its infection)	2	10
Placement of degloving tissues with critically impaired blood supply in their original place	2	10
Coverage of crushed muscles and devascularized fascia using viable integumentary tissues	3	15
Unreasonable operation to cover skin defect (method of choice)	3	15
Unreasonable operation to cover skin defect by timing (length) of the operation	11	55
Unreasonable use of the vacuum system for wound treatment	2	10
Technical errors	6	30
Application of relaxing incisions on the degloved skin leading to additional disorder of intradermal circulation (necrosis of a significant part of the flaps was noted)	2	10
Leaving non-viable fascia and muscles in the wound covered with stretched integumentary tissues led to the development of purulent septic complications.	3	15
Unstable osteosynthesis for bone fractures	1	5

Table 4

Complications and unfavorable treatment outcomes

Types of complications and unfavorable outcomes	Group 1		Group 2*	
	abs.	%	abs.	%
Long wound process	20	100	0	0
Marginal necrosis of skin grafts	0	0	5	25
Extensive ischemic necrosis	5	25	0	0
Deep infection	6	30	0	0
Graft lysis	3	15	0	0
Lethal outcome	2	10	0	0

* – $p^{1-2} = 0.05$ according to Mann-Whitney test

We can demonstrate the above with clinical example of a patient with several "classic" medical and tactical failures. Female patient B., aged 54 years, was squeezed in between a bus and a car in a road accident. Right gluteal and right femoral area were mainly hit. The ambulance team transported her to the Regional Clinical Hospital of Chelyabinsk. Examination (clinical and radiological) was performed. The patient was diagnosed with degloving integumentary tissues of the right femur (9 % degloving area). After that the primary surgical treatment of wounds of the right lower limb was urgently performed. During the operation multiple relaxing and draining incisions were made on the skin of the right femur and the wound was sutured with tissue tension. In the postoperative period, despite treatment, the necrosis of degloving tissues began to develop on the background of antibiotics and disaggregants administration. In 2 weeks after injury, a combustiologist from the Burn Center of Chelyabinsk city was invited for consultation. At the time of examination on the 16th day after injury, the patient was in moderate condition caused by the injury and complicated by the course of the wound process and

purulent resorptive fever. The consultation resulted in the transfer of the patient to the Burn Center and further treatment. After the transfer, secondary surgical treatment of the wound was performed. It was revealed that the area of degloving integumentary tissues was 9 % in the right femoral area (circular injury) and 6 % in the right gluteal and lumbar region. Affected integumentary tissues with skin necrosis and necrotic wounds at the site of incisions made on degloving flaps are visible (Fig. 1, 2, 3). Figure 4 (day 18 from the moment of injury) shows the mosaic nature of the ischemia and skin necrosis development, areas of mummified skin, parts of pronounced venous congestion and ischemic phlyctena. The above combined with the infection process, made it impossible to cover affected skin with a full-layer or split autodermal graft. The removed skin was utilized. If the secondary revision of the wound had been made earlier (at least on the 4th to 6th day), then the loss of plastic material could be avoided. Split skin autografts from other parts of the patient's body were used to close the wounds. Figure 5 shows the result of treatment of patient B. in 12 months after discharge from the hospital.



Fig. 1 Photo of the lower limbs of patient B., 54 years old, taken in 17 days after the injury. Affected integumentary tissues with skin necrosis and necrotic wounds at the site of incisions in degloving flaps are observed



Fig. 2 Photo of the lower limbs of patient B., 54 years old, taken in 17 days after the injury. Extensive necrotic tissues located deeply in femur and circular character of integumentary tissues injury of the right femur are observed in repeated surgical treatment of wound



Fig. 3 Photo of the right femur of patient B. It can be seen that Below removed degloving tissues, the muscle dissociation and areas of necrosis are observed



Fig. 4 The view of degloving and partially necrotic skin



Fig. 5 Photo of the lower limbs of patient B. Treatment result

DISCUSSION

Most complications in patients with degloving injury of integumentary tissues were caused by organizational, diagnostic, therapeutic, tactical and technical failures but some of the complications were associated with the severity and extent of injuries.

Degloving integumentary tissues is not included in the list of nosological forms of ICD-10 as a diagnosis[25]. Currently this type of injury is not singled out separately in the list of nosologies of the Federal Compulsory Medical Insurance Fund on traumatology. Correspondingly, the medical records of these patients are accessed according to other coding. In its best, the diagnosis is coded as a polytrauma (and the injured is examined by several specialists). At worst it is stated as a wound or contusion (in this case, the diagnosis does not make up your mind to the severity of the problem). Sometimes the coding states a fracture, damage to blood vessels or nerves, that also does not reflect the necessary examination and treatment. There is no approved volume of examination of soft tissues, required methods of treatment and criteria to implement the standard procedures for this pathology. There are no

clinical recommendations for the treatment of patients with this pathology, approved by the Ministry of Health of the Russian Federation.

The lack of plans for routing the injured is to be referred to the organizational failure that existed before and exists at the present time. The patients undergo treatment in surgical, trauma, combustiology and infection departments. This position of affairs indicates the absence of united optimal approach in diagnostics and treatment for providing maximal positive result.

We cannot report on violation of an order on the patients' routing since it does not exist. We believe the best option for admitting the patient with degloving integumentary tissues should be urgent admission in multidisciplinary medical organizations with the trauma centers of the 1st or 2nd levels. These organizations provide a full range of medical care at the hospital stage to the patient with combined, multiple and isolated injuries, accompanied by shocks and their complications and consequences. They include an anti-shock operating room; specialized intensive care unit; trauma department (combined trauma); specialized departments (trauma and orthopedics,

neurosurgery, general surgery) [26]. We consider the possibility of involving vascular surgeon, plastic surgeon or combustiologist in diagnostics and treatment within 1–2 hours to be a special condition (meaning not the appropriate certificate only but the ability to work with integumentary tissues and the skills of closing wound defects and using autodermal grafts). The extensive tissue damages, their infection and the problem of persisting wound surfaces bear the prerequisites for the development of many complications. However, in the national and foreign literature, their analysis is fragmentary.

Portuguese doctors Milcheski D.A. et al. (2010) [15] retrospectively assessed the results of treatment of 21 patients with degloving lesions of the lower limbs. The following 11 complications were stated: 3 cases of amputation, that were associated with the severity of the injury; arterial thrombosis (1 case); osteomyelitis (1 case); tetraplegia and exposure of bones (1 case each). Two lethal outcomes occurred during treatment and were caused by sepsis and acute renal failure (1 case each).

A group of authors headed by Yan H. [27] treated 102 patients (129 injured limbs) over 9 years. The mean age of the injured was 32.5 years (ranged from 6 to 75 years) including 87 males and 15 females. Among them, there were 94 cases of car collision, 8 cases of workplace accidents due to roller devices. Ninety-seven people were followed up for mean 3.1 years (from 1 to 8 years). Most of the patients were satisfied with the cosmetic appearance of their injured limb, while three individuals complained on distorted contour of their limbs due to the transfer of the tissue complex. Flexion contracture of the ankle and knee with minimal limitation of range of motion was registered in six patients. Eight people periodically noted the appearance of erosions in the popliteal fossa, and were treated conservatively.

Another author, Dr. Kudsk K.A. [28], described that out of 21 patients with degloving integumentary tissues, two persons died on the 2nd and 7th days, amputations were performed in five cases and in three cases there were necrosis of transferred full-thickness skin autografts.

Dr. Oleinik G.A. [29] from the Kharkiv Medical Academy of Postgraduate Education presented the results of analysis on the efficiency of treatment of 427 patients with scalped wounds and extensive wound defects of the upper and lower limbs for the period from 2009 through 2013. There were two cohorts in his work. The first cohort included 314 cases who underwent conventional treatment including visual subjective determination of the viability of scalped tissues, PST of the wound, flap replantation, preventive vascular and antibacterial therapy. The second cohort (main) included 113 patients who underwent treated according to the scheme developed in the clinic. In evaluation of this scheme the efficiency for providing care to the patients with scalped wounds and extensive wound defects, the decrease in incidence of flaps necrosis by 9 %, marginal necrosis by 11 % and the same with complete rejection of grafts by 6 % were observed.

Belarusian authors V.N. Bordakov, I.A. Elin, P.V. Bordakov, M.V. Doronin, A.A. Sukharev, D.S. Savitsky, K.F. Ezersky [2] presented a review article on the diagnostics and treatment tactics in the management of patients with traumatic degloving soft tissue. The authors, unfortunately, did not reported the number of patients who underwent their treatment. Therefore, there is no data on the percentage of failures and complications they encountered. However, their description of failures and complications is typical for this pathology. The authors highlight the errors in the diagnostics of continuous bleeding into the degloving cavity, indicate the possible inadequate assessment of the degloving tissues viability, that leads to incorrectly chosen treatment tactics. The authors describe the following management failures: inadequate surgical treatment of extensive degloving skin, i.e. limitation only by drainage of the degloving cavity; skin suturing with interrupted sutures; perforation of the skin with separate incisions; primary surgical treatment with the application of primary (“blind”) sutures; and primitive continuous dressing of the degloving area.

Daniel Francisco Mello et al [17] shared their experience of 47 patients treatment. The article indicates that complications were observed in 29 (62 %) injured. In 12 cases, the infection, i.e. necrosis in the degloving area, was noted, when seven of them were evaluated late, and five were assessed in a due time. 5 patients had problems with fixation of concomitant bone fractures. Also, 5 patients had pneumonia complication. Complications in blood transfusion and coagulopathy were observed in 7 cases and stress ulcers were stated in 3 cases. Two patients (4.2 %) died on days 15 and 25 of their stay.

Hakim et al. [30] presented the treatment experience of 178 patients. Having up-to-date diagnostic equipment and knowledge of patients’ treatment with skin defects, the authors report the following complications in all their patients with open and closed degloving skin: skin infection was observed in 3.9 % of cases, skin necrosis was in 1.1 % and mortality reached 9.0 %.

Chinese colleagues Chen Y. and Liu L. [18] describe the treatment results of 54 cases with degloving skin of the lower limbs. Mean age was 35.7 years (ranged from 16 to 65 years). Mechanism of injury was as follows: traffic accident in 44 cases, hitting with heavy objects in 8 cases and falling from height in 2 cases. The injury was registered in 31 femur, 19 lower legs and 4 feet. The size of lacerations ranged from 10–15 cm² to 30–50 cm². Hemorrhagic shock occurred in 16 cases and 5 patients sustained femoral fractures and 7 had tibial ones. Results were as follows: all 54 patients survived and recovered and were discharged without amputations. The authors noted the infection complications in up to 54 % of the cases if the there were wounds in the femur.

Lekuya H.M. et al. (Uganda) [31] treated 46 patients within 5 months (51 degloving injury). The mean age of the injured was 28.8 years; in 84 % of the cases the injuries were caused by road accidents and led to the shock on admission in 29 %. In 33 cases, degloving injuries were

combined with the fractures and in 18 cases there were no fractures. Lethal outcome developed in 6 injured (13.04 %). Complications were observed in 15 patients (33 %): local infection – in 8 cases, chronic ulcer – 4, osteomyelitis – 4, sepsis – 3, segmental amputation – 3, loss of skin flaps – 3, necrotizing fasciitis – 1.

A prospective study of 48 patients admitted with degloving injury of integumentary tissues was performed in one of the hospitals in Kenya from December 1, 2016 through November 30, 2017 [14]. The mean age of the patients was 26 years with male to female ratio of 1.5:1. The majority (75 %) of injuries were caused by traffic accidents mainly (n = 23) involving the lower limbs. Treatment included either one-stage (n = 29) or serial surgical treatment of wounds (n = 15). The most common definitive treatment involved primary wound closure (n = 22). Closed degloving injuries were treated conservatively. Complications developed in 31.2 % of the cases. These early complications included local wound infection (40 %), bleeding (26.7 %), graft failure (20 %), and primary flap necrosis in 13.3 %.

Summarizing the results of our own study and analysis of literature sources, we propose the following measures to prevent the failures and complications:

1) we believe that patients with degloving injury of integumentary tissues should be transported to trauma centers of the first level during the first day after injury. The current level of medicine makes it possible to transport patients in shock condition with all the necessary anti-shock procedures;

2) at first-level trauma center, the patient with high-energy injury should be treated by multidisciplinary team of specialists, with the participation of a doctor specializing in treatment of wounds and wound defects (ideally, a plastic surgeon);

3) application of current diagnostic procedures (ultrasound, CT with vascular contrast, MRI, thermal imager, polarography) should be carried out within the next day after trauma. That allows to diagnose the

patient precisely and in due time to avoid complications, define the severity of tissue damage and choose proper surgical strategy;

4) optimal ways of primary surgical treatment and drainage of the wound:

a) tissue revision is performed after stabilization of the patient's condition, and in case of continuous bleeding according to emergency indications. In PST, it is necessary to assess the viability of integumentary tissues, muscles and fascia. Sparing excision of affected tissues should be produced;

b) isotonic solutions (physiological saline) should be used for washing wounds;

c) all wound pockets should be drained using thick silicone tubes; it is advisable to loosely swab large contaminated wounds after PST with isotonic sodium chloride solution;

d) suture of the wounds with tension of integumentary tissues is unacceptable;

e) it is necessary to exclude the implementation of small incisions on degloving tissues in order to approximate the edges of wounds;

5) treatment of the skin with solution of brilliant green (or other coloring antiseptics) makes it difficult to visually assess the condition of the integumentary tissues (hyperemia, cyanosis, vascular reaction) and should be excluded from the toolkit of medical care;

6) tissue condition monitoring should be carried out at least once every 4–6 hours and dressings should be changed under anesthesia;

7) vacuum bandages are to be applied with a minimum vacuum within the first 5 days in order to prevent bleeding.

Our comparative analysis of the treatment outcomes in traumatic degloving skin depending on the timing of admission to the combustiology department is limited by small samples of patients. However, the difference in the incidence of unfavorable outcomes in these random samples turned out to be statistically significant.

CONCLUSION

Among the complications occurred during the treatment of the patients with extensive degloving injuries of integumentary tissues, the first place belongs to the tissue necrosis (44.4 % of cases among all complications), that reflects the severity of the injury and in most cases require additional restorative and plastic surgeries. Infection complications, confirmed by microbiological

data, amounted to 9.6 %. The main measures to prevent failures and complications in traumatic degloving skin include the transportation of the injured to the first level trauma centers during the first day, the organization of multidisciplinary teams, the use of current highly informative diagnostic procedures, optimal methods of primary surgical treatment and early vacuum drainage.

REFERENCES

1. Belenkii I.G., Spesivtsev A.Iu., Imshennik O.V., Ramade U.A. Zakrytaia travmaticheskaja otsloika kozhi: printsipy diagnostiki i lecheniia [Closed traumatic skin detachment: principles of diagnosis and treatment]. *Ambulatornaia Khirurgiia*, 2004, no. 1, pp. 38-40. (in Russian)
2. Bordakov V.N., Elin I.A., Bordakov P.V., Doronin M.V., Sukharev A.A., Savitskii D.S., Ezerskii K.F. Travmaticheskaja otsloika miagkikh tkanei: diagnostika i lechebnaia taktika [Traumatic detachment of soft tissues: diagnosis and treatment tactics]. *Voennaia Meditsina*, 2015, no. 4, pp. 116-119. (in Russian)
3. Korostelev M.Yu., Shikhaleva N.G. Sovremennoe sostoianie problemy lecheniia patsientov s obshirnymi otsloikami pokrovnykh miagkikh tkanei (obzor literatury) [Current state of treating patients with extensive degloving injuries of integumentary soft tissues (literature review)]. *Genij Ortopedii*, 2017, vol. 23, no. 1, pp. 88-94. DOI 10.18019/1028-4427-2017-23-1-88-94.
4. Krasovitev V.K. *Pervichnaia plastika ottorgnutymi loskutami kozhi: (s dobavleniem literaturnogo obzora autoplastiki)* [Primary plasty with torn skin flaps: (with the addition of a literature review of autoplasty)]. Krasnodar, Krasnodarskoe Kraevoe Knigoizdatelstvo, 1947, 239 p. (in Russian)
5. Loktionov P.V., Gudz Iu.V. Opyt lecheniia ran nizhnikh konechnostei s obshirnoi travmati-cheskoi otsloikoi kozhi i podkozhnoi kletchatki

- [Experience in the treatment of wounds of the lower limbs with extensive traumatic detachment of the skin and subcutaneous tissue]. *Mediko-Biologicheskie i Sotsialno-Psikhologicheskie Problemy Bezopasnosti v Chrezvychaynykh Situatsiyakh*, 2015, no. 1, pp. 22-28. (in Russian) DOI: 10.25016/2541-7487-2015-0-1-22-28.
6. Mikusev I.E., Mikusev G.I., Khabibullin R.F. Travmaticheskaya otsloika kozhi: voprosy diagnostiki i lecheniya [Traumatic skin detachment: problems of diagnosis and treatment]. *Prakticheskaya Meditsina*, 2013, no. 1-2 (69), pp. 104-107. (in Russian)
 7. Antoniou D., Kyriakidis A., Zaharopoulos A., Moskoklaidis S. Degloving Injury. *Eur. J. Trauma*, 2005, vol. 31, pp. 593-596. DOI: 10.1007/s00068-005-1059-3.
 8. Pilanci O., Aköz Saydam F., Başaran K., Datlı A., Güven E. Management of soft tissue extremity degloving injuries with full-thickness grafts obtained from the avulsed flap. *Ulus Travma Acil Cerrahi Derg.*, 2013, vol. 19, no. 6, pp. 516-520. DOI: 10.5505/tjtes.2013.64928.
 9. Latifi R., El-Hennawy H., El-Menyar A., Peralta R., Asim M., Consunji R., Al-Thani H. The therapeutic challenges of degloving soft-tissue injuries. *J. Emerg. Trauma Shock*, 2014, vol. 7, no. 3, pp. 228-232. DOI: 10.4103/0974-2700.136870.
 10. Andres T., von Lübken F., Friemert B., Achatz G. Vacuum-Assisted Closure in the Management of Degloving Soft Tissue Injury: A Case Report. *J. Foot Ankle Surg.*, 2016, vol. 55, no. 4, pp. 852-856. DOI: 10.1053/j.jfas.2015.12.002.
 11. Zgonis T., Cromack D.T., Roukis T.S., Orphanos J., Polyzois V.D. Severe degloving injury of the sole and heel treated by a reverse flow sural artery neurofasciocutaneous flap and a modified off-loading external fixation device. *Injury Extra*, 2007, vol. 38, no. 5, pp. 187-192. DOI: 10.1016/j.injury.2006.08.067.
 12. Wójcicki P., Wojtkiewicz W., Drozdowski P. Severe lower extremities degloving injuries – medical problems and treatment results. *Pol. Przegl. Chir.*, 2011, vol. 83, no. 5, pp. 276-282. DOI: 10.2478/v10035-011-0043-3.
 13. Gavrishchuk I.A., Mikitiuk S.I., Demko A.E., Kazhanov I.V., Nikitin A.V. Lechenie postradavshei s politravmoi i obshirnoi travmaticheskoi otsloiki kozhi nizhnego konechnosti [Treatment of the injured lower limb with polytrauma and extensive traumatic detachment of the skin]. *Vestnik Khirurgii im. I.I. Grekova*, 2018, vol. 177, no. 4, pp. 83-85. (in Russian) DOI: 10.24884/0042-4625-2018-177-4-83-85.
 14. Mutiso D.M., Maoga N., Ayumba B.R., Ashraf E.M. Degloving injuries: Patterns, treatment and early complications among patients at a Teaching Hospital in Western Kenya. *East African Orthopaedic Journal*, 2021, vol. 15, no. 2, pp. 84-90.
 15. Milcheski D.A., Ferreira M.C., Nakamoto H.A., Tuma P. Jr., Gemperli R. Tratamento cirúrgico de ferimentos descolantes nos membros inferiores: proposta de protocolo de atendimento [Degloving injuries of lower extremity – proposal of a treatment protocol]. *Rev. Col. Bras. Cir.*, 2010, vol. 37, no. 3, pp. 199-203. (in Portuguese) DOI: 10.1590/s0100-69912010000300007.
 16. Mello D.F., Asséf J.C., Soldá S.C., Helene A. Jr. Degloving injuries of trunk and limbs: comparison of outcomes of early versus delayed assessment by the plastic surgery team. *Rev. Col. Bras. Cir.*, 2015, vol. 42, no. 3, pp. 143-148. (in English, Portuguese) DOI: 10.1590/0100-69912015003003.
 17. Chen Y., Liu L. Clinical analysis of 54 cases of large area soft tissue avulsion in the lower limb. *Chin. J. Traumatol.*, 2016, vol. 19, no. 6, pp. 337-341. DOI: 10.1016/j.cjtee.2016.09.003.
 18. Russian Federation. Order of the Ministry of Labor and Social Protection of the Russian Federation No. 698n of November 12, 2018, Ob utverzhenii professionalnogo standart "Vrach-travmatolog-ortoped" [On approval of the professional standard "Traumatologist-orthopedist"]. *Garant.ru*. Available at: <https://www.garant.ru/products/ipo/prime/doc/72019308/> (accessed 05.04.2021). (in Russian)
 19. Russian Federation. Order of the Ministry of Labor and Social Protection of the Russian Federation No. 743n of November 26, 2018, Ob utverzhenii professionalnogo standart "Vrach-khirurg" [On approval of the professional standard "Surgeon"]. *Ofitsialnyi internet-portal pravovoi informatsii* [Official Internet portal of legal information]. Available at: <http://publication.pravo.gov.ru/Document/View/0001201812120018> (accessed 05.04.2021). (in Russian)
 20. Russian Federation. Order of the Ministry of Labor and Social Protection of the Russian Federation No. 482n of July 31, 2020, Ob utverzhenii professionalnogo standart "Vrach-plasticheskii khirurg" [On approval of the professional standard "Plastic surgeon"]. *Ofitsialnyi internet-portal pravovoi informatsii* [Official Internet portal of legal information]. Available at: <http://publication.pravo.gov.ru/Document/View/0001202008170011> (accessed 05.04.2021). (in Russian)
 21. Kurinnyi S.N., Blazhenko A.N., Bogdanov S.B., Marchenko D.N., Aladina V.A., Deinichenko N.S. Osobennosti plastiki polnosloinym kozhnym autotransplantatom u postradavshikh s travmaticheskoi otsloikoi kozhi v zavisimosti ot otsenki tiazhesti sostoianiia i razrusheniia miagkikh tkanei [Characteristic features of plasty with a full-layer skin autograft in patients with traumatic skin detachment depending on the assessment of the severity of the condition and the destruction of soft tissues]. *Plasticheskaya Khirurgiia i Esteticheskaya Meditsina*, 2020, no. 3, pp. 45-52. (in Russian) DOI: 10.17116/plast.hirurgia202003145.
 22. Blazhenko A.N., Kurinnyi S.N., Mukhanov M.L., Blazhenko A.A., Afaunov A.A. Klinicheskoe nabliudenie uspeshnogo lecheniya postradavshago s politravmoi i obshirnoi travmaticheskoi otsloikoi kozhi levei goleni [Clinical observation of successful treatment of an injured patient with polytrauma and extensive traumatic detachment of the skin of the left leg]. *Politramma*, 2019, no. 3, pp. 71-76. (in Russian)
 23. Bogdanov S.B., Blazhenko A.N., Kurinnyi S.N., Mukhanov M.I., Boiko A.A., Karakulev A.V., Aladina V.A. Aktualnye aspekty okazaniia meditsinskoi pomoshchi detiam s obshirnymi povrezhdeniami miagkikh tkanei (opisanie trekh klinicheskikh nabliudenii s razborom dopushchennykh pri lechenii oshibok) [Current aspects of medical care for children with extensive soft tissue injuries (description of three clinical cases with analysis of errors made in the treatment)]. *Ortopediia, Travmatologiia i Vosstanovitelnaia Khirurgiia Detskogo Vozrasta*, 2021, vol. 9, no. 1, pp. 107-114. (in Russian) DOI: 10.17816/PTORS48471.
 24. Korostelev M.Yu., Shikhaleva N.G., Klimov O.V. K voprosu o klassifikatsii travmaticheskikh otsloek pokrovnykh tkanei [Classification of traumatic integumentary tissue degloving]. *Genij Ortopedii*, 2021, vol. 27, no. 2, pp. 169-174. DOI 10.18019/1028-4427-2021-27-2-169-174.
 25. *International Statistical Classification of Diseases and Related Health Problems* / World Health Organization. Vol. 3. An alphabetical index to diseases and nature of injury, external causes of injury, table of drugs and chemicals. Instruction manual. ICD-10.
 26. Poroiskii S.V., Iarmolich V.A., Mikhno V.A. Analiz realizatsii programmy etapnoi meditsinskoi pomoshchi postradavshim v DTP na trasse M6 [Analysis of the implementation of the program of staged medical care for injured persons in the RTA (road traffic accidents) on the M6 highway]. *Materialy III Mezhdunarodnoi Nauchno-Prakticheskoi Konferentsii v ramkakh foruma «Bezopasnosti i Sviaz» «Sovremennye Problemy Bezopasnosti Zhiznediatelesti: nastoiashchee i budushchee»* [Proceedings of the III International Scientific-Practical Conference "Modern problems of Life Safety: present and future", as part of the "Security and Communications" Forum]. Kazan, 2014, Part II. (in Russian)
 27. 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, vol. 74, no. 2, pp. 604-610. DOI: 10.1097/TA.0b013e31827d5e00.
 28. Kudsk K.A., Sheldon G.F., Walton R.L. Degloving injuries of the extremities and torso. *J. Trauma*, 1981, vol. 21, no. 10, pp. 835-839. DOI: 10.1097/00005373-198110000-00002.
 29. Oleinik G.A. Sovremennaya taktika diagnostiki i lecheniya skalpirovannykh ran konechnosti [Modern tactics of diagnostics and treatment of scalped limb wounds]. *Kharkivska Khirurgichna Shkola*, 2014, no. 5, pp. 37-43. (in Russian)
 30. Hakim S., Ahmed K., El-Menyar A., Jabbour G., Peralta R., Nabir S., Mekhodathil A., Abdelrahman H., Al-Hassani A., Al-Thani H. Patterns and management of degloving injuries: a single national level 1 trauma center experience. *World J. Emerg. Surg.*, 2016, vol. 11, pp. 35. DOI 10.1186/s13017-016-0093-2.
 31. Lekuya H.M., Alenyro R., Kajja I., Bangirana A., Mbiine R., Deng A.N., Galukande M. Degloving injuries with versus without underlying fracture in a sub-Saharan African tertiary hospital: a prospective observational study. *J. Orthop. Surg. Res.*, 2018, vol. 13, no. 1, pp. 2. DOI: 10.1186/s13018-017-0706-9.

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