Degloving injuries consist in detachment of skin and subcutaneous tissue from underlying fascia and muscles. They mostly address total surface of extremities or trunk, resulting in high morbidity and mortality. Their treatment, due to severity of the injury, high percentage of serious concomitant injuries and massive blood loss is time-consuming and its results are often unfavourable.

The authors present results of treatment of three cases of patients with degloving injuries of the lower extremities and trunk. The patients presented poor healing prognosis connected with the extent of the injury. A complicated course of treatment was described. In all patients skin grafts healed well, resulting in acceptable aesthetic and functional outcome.

Key words: degloving injury, Morell-Lavallée injury, skin graft
injuries into four groups: circumscribed degloving injury caused by tangential forces, non-circumferential degloving, single-planar non-circumferential degloving (1).

The main problem in case of degloving injuries treatment, especially interesting large percentage of body surface area, is the integument defect closure. Early reconstruction reduces the risk of complications occurrence, among which infections and the need for limb amputation for life salvage are the most life-threatening ones.

The most simple and frequently used treatment is to re-suture *in situ* the avulsed flap. This kind of procedure often results in partial or total loss of resutured tissues (1, 5, 6) especially in case of circumferential degloving injuries (1).

Mapping with the use of fluorescein is employed with the aim to determine the vascularization of avulsed flap (4). Accurate tissues viability assessment using fluorescein is complex and not fully accurate, which, according to some authors, disqualifies this method (5).

Oztuna et al. proved that intraperitoneal administration of pentoxyfiline in rats improves viability of experimentally created cutaneous flaps (7). According to numerous authors, re-attachment of the avulsed flap in situ and compressive garments do not bring expected results. They recommend, as the procedure of choice, wound debridement and coverage of the defect with split or full thickness skin grafts (5). These conclusions were based on the analysis of treatment results of a group of 21 patients who suffered from circumferential degloving injury involving at least two thirds of limb circumference. Authors suggest the possibility of skin grafting from the avulsed skin, provided the avulsed skin quality allows such a procedure (1, 5, 6). Such treatment option enables to spare donor area and, in consequence, to reduce the whole wound surface. In order to maximize the total area of skin grafts, especially in case of extensive degloving injuries, a three-layer grafting technique from avulsed flap is proposed (6).

Two outer (superficial) layers, consisting epidermis and dermis superficial layer and dermis, respectively, are used to cover the wounds. The most profound layer deprived of subcutaneous tissue serves as a temporary biological dressing. Skin grafts obtained from avulsed skin may also be prepared by de-fatting and perforating by means of incision or fenestration prior to wound coverage (8, 9). In case of upper limb degloving a delayed split thickness skin graft from avulsed flaps is described. After twelve days from the injury, a well-developed granulating wound bed was covered with frozen skin graft (10).

Microsurgical technique enables wider use of avulsed skin flaps. Waikakul (11) regards avulsed tissues as a perforator-based flap, which may be sutured in situ with use of microsurgical anastomoses. This kind of procedure is advocated if the skin is not extensively damaged and if vessels for microsurgery – both in donor and recipient site are of sufficient quality.

Morell-Lavallée degloving constitutes a particular type of degloving injury (1, 3, 5, 12). Infection affecting the hematoma which dissect the tissues from underlying fascia may lead to abscess formation and skin necrosis. Most of the authors suggest opening the fluid collections and their drainage. However, some reports describe successful closed Morell-Lavallée injury treatment combined with compressive therapy and decompression punctures (12, 13). Degloving injuries resulting in extensive open wounds, massive blood loss, frequently coexisting multiple concomitant injuries are connected with high rate of serious complications and early as well as late mortality rate (1-5, 8, 9, 10).

Degloving injuries complications may be divided into general and local – both early and late. Serious infection or sepsis and lower limbs deep vein thrombosis constitute a grave threat. Consequences of massive blood transfusions are also to be taken into account. Early local complications include haemorrhage, distal ischaemia, skin graft healing disorders, infection, limb amputation necessity in life-saving indications. Late local complications consist in limb contour deformity, chronic wounds and ulcerations, potentially leading to Marjolin ulcer, contracting scars, sensation disorders and lymphedema.

In case of impaired wound healing, especially coexisting with open bones fractures, negative pressure dressings (VAC™) use is advocated in order to accelerate wound healing process (14).

We present three cases of patients suffering from serious degloving injuries of lower limbs...
CASE REPORTS

1. Patient K.R., 20 years old. As a result of a serious traffic accident, she suffered from a multi-organ injury involving open right femur and tibia fractures with deficit of soft tissues and quadriceps femoris muscle rupture, right pubic bone fracture with pubic symphysis dilatation and right lung contusion. In effect, a hypovolemic shock and crush syndrome developed.

Primarily the patient was hospitalized in Wojewódzki Szpital Specjalistyczny (Wojewódship Specialistc Hospital) Intensive Care Unit in Wrocław. On the fifth day from the injury, after stabilization of her vital parameters and bone fractures management, due to evolving gas gangrene she was transferred to Klinika Medycyny Hiperbarycznej i Ratownictwa Morskiego (Hyperbaric Medicine and Marine Rescue Clinic) in Gdynia in attempt to continue the infection treatment. Skin necrectomy, subcutaneous tissue and fragments of adductor femoris muscle debridement were performed. Hyperbaric oxygen therapy (18 procedures) and antybioticotherapy according to antybiogram result were implemented. Due to right pleural fluid collection drainage was performed. The therapeutic schedule was completed by bilateral paracentesis. On the tenth day microbiologically clear wound covered with regular granulation tissue was obtained.

The patient was transferred to our clinic with the intention to close the right lower limb soft tissue defect. On admission, right lower limb skin and subcutaneous tissue defect was observed. It involved its anterio-medial surface. Moreover, a partial adductor femoris muscle defect was present. The defect area delineation consisted in a line starting at greater trochanter, traversing obliquely the thigh over Hunter canal towards medial knee region, and transversing popliteal fossa towards posterio-medial surface of the calf. It followed the medial border of gastrocnemius muscle up to the middle part of the calf and reached the anterior surface of the lower leg in proximity of the tuberositas tibiae. It followed the lateral border of quadriceps muscle and reached the greater trochanter. The wound was covered with regular granulation tissue. In the distal third of the lower leg anterior surface a soft tissue defect of diameter approximetely of 7 cm was present. Fragment of tibia was exposed (fig. 1).

In the first stage, the wounds were debrided and the soft tissue defect was covered with autologous split thickness skin grafts harvested from contralateral defect. Nearly total surface graft healing was obtained. Second stage, performed after three months, consisted in closure of a defect of 7x9 cm located in the distal third of the lower limb, over tibia. After chiseling of the superficial layers of tibia, a retrograde fascial flap measuring 6x8 cm was harvested from contralateral thigh. Nearly total surface graft healing was obtained. Second stage, performed after three months, consisted in closure of a defect of 7x9 cm located in the distal third of the lower limb, over tibia. After chiseling of the superficial layers of tibia, a retrograde fascial flap measuring 6x8 cm was

![Fig. 1. Extensive wound of right thigh and lower leg caused by degloving injury](image1)

![Fig. 4. Long-term treatment outcome](image4)
sutured into the defect. Afterwards, its outer surface was covered with autologous skin graft. Total hospitalization time was 30 days.

On a check-up performed after 44 months from the injury and 40 months from the treatment we noted permanent closure of the soft tissues defect both on thigh and lower leg. At present, the patient studies, ambulates unassisted, without restrictions (diminished knee flexion angle to 85-90 degrees).

2. Patient S.M., 71 years old. She experienced right leg degloving injury in a traffic accident. Due to her grave general conditions on admission and accident circumstances amnesia, its mechanism was reconstructed basing on accident witnesses testimonies. She was probably hooked by a side of a passing lorry and, in consequence, her right leg suffered from an extensive degloving injury. The tissues involved were skin, subcutaneous tissue, fascia and superficial layers of upper and lower leg muscles. These tissues were totally and circumferentially detached from underlying anatomical structures.

The upper delineation of degloving area extended from upper anterior iliac spine through perineum and perianal region, not affecting anal sphincters, passing along lower border of greater gluteus muscle to greater trochanter. The lower border was on the level of ankle. An isolated wound of the lateral ankle region of the surface equal to 1% of total body surface was the result of skin friction against the ground.

The patient was transferred to our department from a regional hospital distant 200 km, few hours (5, 6, 7) after the injury. Due to evolved hypovolemic shock and extremely severe patient general condition, she was immediately subject to resuscitation procedures with compressive dressings left in situ. After a few hours, as soon as patient’s general condition stabilized, the patient was operated on in the operating theatre. Haemostasis was achieved and the wound was covered with the avulsed skin flap, which was distally vascularized. Patient in stable general condition was transferred to intensive care unit. After few hours, the patient’s general condition started to deteriorate. Decrease in plasmatic proteins level and blood coagulation disorders occurred. Enlargement of the necrotic tissues area enhanced the threat of developing a septic shock. The patient was urgently transferred to the operating room for life-saving surgery. Split thickness skin grafts were harvested from the avulsed flap by means of an electric dermatome. The ischaemic skin originating from thigh and lower leg was removed to the level of 5-10 cm above ankle. The wound margins consisting in widely detached skin in groin, perineum and gluteal region were refreshed. Damaged muscles with large tissue loss were debrided (fig. 2). Whole surface of the lower limb wound was covered by split thickness skin grafts harvested from the contralateral leg and
Avulsed skin. Large drains were placed in deep muscle fissures and their endings were attached over the dressings. Skin grafts were covered with sterile waseline – soaked dressings (Jelonet®) and several layers of dry sterile gauze.

After the operation the patient was transferred to intensive care unit. In order to obtain efficient analgesia, a permanent infusion of bupiwacaine solution through epidural catheter was employed. Empirical, followed by aimed antibiotic therapy according to wound antibiogram was introduced. Parenteral nutrition and albumin infusions were applied. Blood and blood derivatives (Fresh Frozen Plasma, Red Cell Concentrate) were used. In effect, basic vital parameters were stabilized. Skin grafts were healed nearly on the whole wound surface. Small residual wounds were covered with skin grafts harvested from contralateral upper and lower limbs in the following treatment stages.

In upper thigh region, corresponding to damaged gluteus muscle, chronic inflammation persisted, which impaired skin grafts healing. A few – centimeter – wide, proximally vascularized flap of avulsed skin was left in the inguinal region. Treatment – resistant infection impaired graft healing. Wound debridement and their coverage with split thickness skin grafts took another 6 weeks before the wounds could be regarded as nearly healed. At this point the patient was referred to her regional orthopaedic surgery department for final treatment.

At a check – up at 34 weeks from the injury the patient presented with fully closed soft tissue defects with well – healed skin grafts, resulting in acceptable aesthetic and functional outcome. No joint contractures were noted and the patient maintained total passive and active mobility of the affected limb.

3. Patient J.W., 76 years old. The patient was admitted to our department due to degloving injury interesting scrotum with concomitant pelvic and abdominal injuries. He was run over by a tractor during works in the field. Imaging studies revealed non – dislocated ilium fracture. On admission scrotal scalpation wound was managed by meticulous debridement and suturing in situ. On day 13 marginal skin necrosis was excised and refreshed wound margins were sutured. Further scrotum wound healing was uneventful.

On hospitalisation day 2 formation and slow increase of a hematoma – seroma dissecting subcutaneous tissue of lumbar, inguinal and right thigh region was noted. Judging from clinical characteristics and injury mechanism, Morell-Lavallée syndrome was diagnosed. Closed degloving area involved anteriorly abdominal integuments on the right side, reaching the medial line, inguinal area (to the scrotum). Superiorly, in the mid axillary line it was delineated by the right costal arch, whereas its medial posterior border was formed by the spine. It involved whole right gluteal region, reaching the intergluteal fold. On the thigh it interested its antero-lateral surface reaching the level of few centimeters above the knee. Compressive dressing and antibiotic therapy were implemented.

On day 3 skin and subcutaneous tissue over maximal fluid deposition thickness areas were incised (fig. 3). Serosanguineous fluid was evacuated. Wounds setonage and antiseptic solutions rinsing were employed. After two days two other decompressing incisions were performed. Negative pressure dressing (VAC™) was applied in order to overcome wound healing impairment. It accelerated wound closure and healing of the detached tissues. Residual wounds corresponding to incision sites were covered with autologous split thickness skin grafts.

On day 74 the patient was discharged from the hospital in good general condition, presenting small residual wounds in advanced healing phase. During further admissions, on week 14 and 16 respectively, sacral region residual wounds were covered with autologous split thickness skin grafts.

RESULTS

In follow-up period of 16 to 49 months from initial treatment all three patients presented permanent closure of soft tissue defects. The skin grafts healed well, presenting no to mild hypertrophic tissue formation (fig. 4, 5). In case of the patient presenting trunk degloving injury no recurrent fluid collections were noted (fig. 6). We reported no disruption of soft tissue cover neither. In all cases lower limbs passive and active motility was satisfactory and did not limit patients’ everyday activities. The esthetic results were satisfactory. All three patients reported moderate paresthesia.
DISCUSSION

Treating the patients presenting degloving injuries is extremely difficult and requests a multidisciplinary approach. The treatment plan is influenced by patient’s general condition, injury extension and the degree of tissue damage. Decision how to treat such a patient is based on clinical picture and the experience of medical team.

Hossenzeideh (15) describes a case of a young patient (24 years old), who experienced lower limb degloving injury as a result of a traffic accident. Circumferential lower leg skin necrosis, interesting also foot dorsal part occurred. A five – centimeter – diameter part of tibia was exposed in its proximal region. Soft tissue defect was covered twice with autologous split thickness skin grafts, resulting in 30 and 100% of graft healing, respectively. Soft tissue defect exposing bone was closed in the next stage using medial gastrocnemius flap.

Cohen et al. (6) describe a case of an 8-years-old boy run over by a lorry, who suffered from degloving injury interesting trunk and lower limbs equal to 60% of whole body area. Authors used skin grafts harvested from avulsed skin by multiple – layer technique, obtaining coverage of the whole wound surface without need for using other areas as donor sites.

In case of bones, tendons, nerves and vessels exposure, the use of flaps from the neighbouring tissues or transferred by means of microsurgery is advocated.

Arnez et al. (1), in case of partial degloving injury recommend necrotic tissues debridement and reconstruction of soft tissues by means of skin grafts or free flaps in case of nerve, tendon, bone and joint exposure. In non – circumferential limb degloving they advocate conservative treatment after meticulous assessment of the detached tissues vascularisation. In case of poor blood supply, they propose necrotic tissues removal with contemporary defect reconstruction using skin grafts or free flaps. Type 3 and 4 (uni- and multiplanar circumferential degloving injury) always nesseciate multistaged necrotic tissues debridement and are connected with prolonged healing resulting in need for soft tissue defect reconstruction performed after detailed muscle vascularisation assessment. Authors advise against suturing of the avulsed skin in situ.

CONCLUSIONS

Degloving injuries are a life – threatening condition. Very often, due to their severity, extension and tissue loss, they may result in massive deformities or limb amputation.
Treatment of such cases should be undertaken by multi specialistic teams in trauma centers.

All three patients described above presented poor healing prognosis connected with complicated course of treatment. It was affected by various negative factors: advanced age, wound infection or serious concomitant injuries. All patients presented good treatment results by means of surgical methods, supported by intensive pharmacotherapy and complementary methods.

REFERENCES


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