

TACTICS OF TREATMENT FOR POSTTRAUMATIC SOFT TISSUE DEFECTS OF EXTREMITIES

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BACKGROUND Due to the non-decreasing incidence of such injuries, prolonged treatment and high incidence of complications, treatment of posttraumatic soft tissue defects of extremities is an actual problem within traumatology and plastic and reconstructive surgery.

AIM OF STUDY Development of tactics for the treatment of posttraumatic soft tissue defects of extremities with the use of vascularized tissues (flaps) and evaluation of its results.

Materials and methods: 118 patients with posttraumatic soft tissue defects of extremities were included into the study. Patients were divided into 2 groups. In the comparison group (49 patients), the traditional management for posttraumatic defects was performed: local treatment of the wound followed by autodermoplasty. In the second group (study group), the developed procedure of cover tissues restoration using vascularized tissue complexes (69 patients) was applied.

RESULTS The developed treatment reduced the incidence of deep wound infection by 13.6%, necrosis of naked functional structures by 36.3%, chronic osteomyelitis by 17% and contraction of adjacent joints by 18.2%. At the same time, we noted a decrease in the duration of inpatient treatment by 14.7 days in patients with posttraumatic soft tissue defects of extremities.

CONCLUSION The developed tactics of cover tissues restoration using vascularized tissue complexes reduced the incidence of complications and improved the functional results of treatment in patients with posttraumatic soft tissue defects of extremities.

Keywords: posttraumatic limb's soft tissue defects, local and free flaps, tactics of surgical treatment

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INTRODUCTION

Skin is the largest organ which main function is to protect the body from the external environment. If a soft tissue defect develops, a wound with edges which can not be approximated, than bone tissue, periosteum, tendons, aponeurosis may be exposed, which leads to their drying with the development of necrosis [1]. The presence of dead tissue contributes to the development of purulent-necrotic infection.

Traditional treatment tactics for traumatic soft tissue defects are open wound management followed by secondary intention healing. The result of secondary wound healing is the formation of coarse scars and contractures of a number of located joints, the development of chronic wound infection. Also, the disadvantage of this tactic of treatment is the long duration of stay in the hospital and painful dressings [2].

Another approach in the treatment of this pathology is to close the soft tissue defect at the early stages with a vascularized flap, which provides a primary intention healing. In this case, local treatment of wounds is considered as a preparatory stage before placing the flap [3]. To close the defect using flaps on a wide base [4], flaps on the vascular pedicle and free flaps. The choice depends on the area and location of the defect, the state of the surrounding tissues, donor and recipient zones, and the severity of the patient's condition.

However, there still unresolved issues of using the displaced blood supplied flaps for the closure of posttraumatic defects of the limbs soft tissues. First, there are no clear criteria for choosing a flap. The choice is largely intuitive, based on knowledge of the anatomy and personal preference of a surgeon. Secondly, there is no consensus on indications for the placement of the flap and the optimal timing of the operation. So, according to S. Gopal et al. (2004) [5], the optimal period for reconstruction is the first 72 hours after injury, which prevents the drying of the underlying tissues, development of necrosis, and contamination with highly virulent microorganisms. However, according to A. Raju et al. (2014) [6], the use of vacuum treatment and the improvement of surgical techniques allow the closure of the defect to be completed within up to 40 days from the moment of injury, while the risks of complications and the functional results of treatment are the same as for immediate reconstruction. The aim of this study is to develop tactics for the treatment of posttraumatic defects in soft tissues of the extremities using vascularized tissue complexes (flaps) and to assess its results of its.

MATERIALS AND METHODS

The study included 118 patients with posttraumatic soft tissue defects, among them 97 were men and 21 were women. The average age of the patients was 38.1 ± 13.4 years.

Defects of the covering tissues of the limbs were the result of the action of a high-energy traumatic agent. Thus, 78 patients were injured in an accident (25 of them were drivers or passengers of a motorcycle), 20 were injured as a result of a fall from the height, 14 had gunshot and mine explosive wounds, 12 were injured in a railway accident, and 9 patients were injured as a result of a heavy object fall on the limb.

In 87 patients, soft tissue defects were accompanied by fractures of the bones, in 26 cases — by detachment or crushing of the limb, in 17 — by exposing the tendon tissue, in 6 — by exposure to intact bone.

In 73 cases, the defects were located on the lower leg, 17 were on the foot, 11 on the hand, 10 on the shoulder, and 9 on the forearm.

During the study, patients were divided into 2 groups. The first group was the comparison group, it included 49 patients with traditional treatment tactics, which is shown on the example of the patient in Fig. 1. Wounds were sanitized, ointment dressings were used in the exudation phase, hydrogel dressings were used in the regeneration phase and, if possible, a vacuum system was applied, which was changed once every 3 days, followed by autodermoplasty. The first dressing after transplantation of the skin graft was performed on the 5th day. Reconstructive operations on the bones in the defect area were postponed until the transplant was fully engrafted, trying to access outside the autodermoplasty zone.

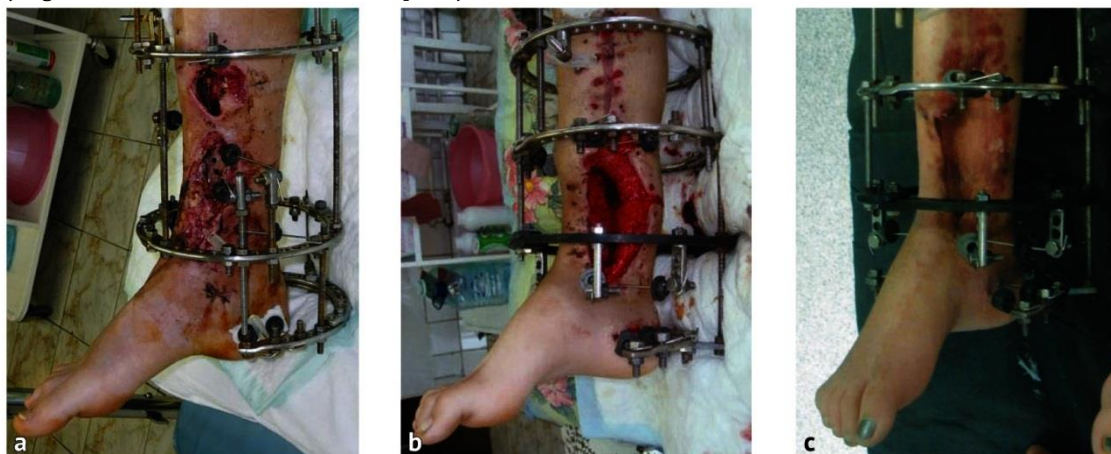


Fig. 1. Tactics of treatment in the comparison group: a – the lower leg wound during the staged necrectomy; b – the lower leg wound after filling the defect with a granulation tissue; c – the lower leg wound after autodermoplasty and engraftment of the skin transplant

The second group was study group, it included 69 patients, who had undergone the tactic of restoring the covering tissues of the extremities, shown on the example of the patient in Fig. 2.

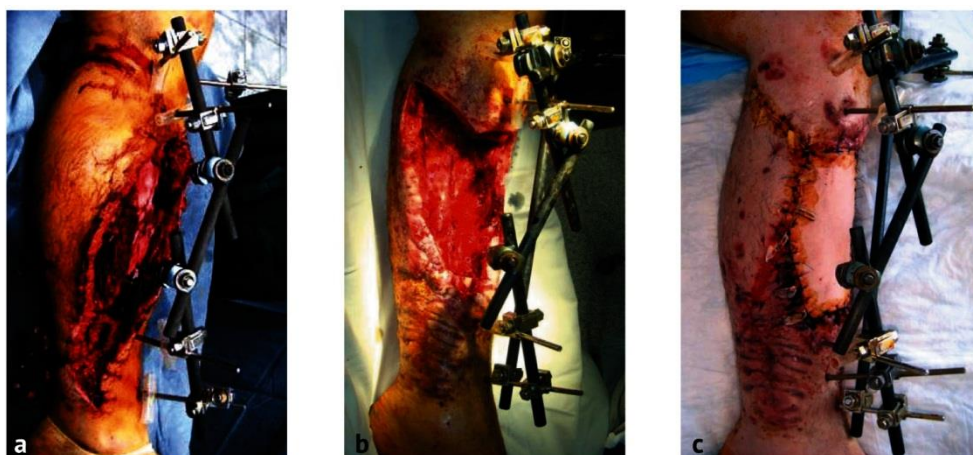


Fig. 2. Tactics of treatment in the study group: a – the soft tissues defect of the lower leg; b – the stage of operation after necrectomy; c – the soft tissue defect, replaced by a free, revascularized flap of the latissimus dorsi muscle

THE TACTICS OF INTEGUMENTARY TISSUES RESTORATION IN VICTIMS WITH INJURIES OF EXTREMITIES IN THE STUDY GROUP

The optimal time for reconstruction of integumentary tissues was considered to be the first 10 days from the trauma, since wound infection does not develop in this period and the bacterial contamination is minimal.

Upon admission, the general condition of the patient was evaluated according to the Pape and Krettek criteria, the location and area of the defect, the presence of exposed functionally important structures in the wound. In a stable condition, the reconstruction was fully performed 2-3 days after injury. In borderline cases, plastic surgery was performed, if possible, by local muscle or skin-fascial flaps, which is less traumatic and takes less operating time. In case of a defect requiring transplantation of a revascularized flap, reconstruction was performed 5-6 days after the injury. In a critical condition, reconstruction was delayed (by the 10th day after injury).

If necrotic tissue (due to blood supply disorders or tissue destruction due to crushing) was there, simultaneous necrosectomy with plasty of the formed defect was performed in the patient's stable state. In case of unstable condition, replacement of the soft tissue defect delayed and performed with the simplest and least traumatic methods.

When planning the surgery, the location and defect area were also evaluated. Local flaps were used for defects of up to 0.5% of the body surface, and free revascularized grafts were used for larger areas. Exceptions were the area of the shoulder and shoulder joint, where flaps were used from the latissimus dorsi, and also the region of the hip joint,

where a flap was used from the lateral vastus muscle. For small defects (up to 0.5% of total body weight), a flap based on the radial artery was used in the area of the elbow joint, forearm, hand, and foot. The clinical observation in which this flap was applied is shown in Fig. 3.



Fig. 3. One-stage restoration of integumentary tissues of the hand with a radial flap

If the defect was more than 1% b.s., only functionally significant structures were closed, such as exposed tendons, bone, and joint areas. The rest of the skin was restored using autodermoplasty.

The lower leg is the most difficult in terms of selecting a flap to restore the tissue, and in this region posttraumatic soft tissue defects appear with greater frequency. In order to standardize the choice of the defect replacement method, the lower leg was formally divided into V levels from the knee joint to the ankle joint, the length of each is approximately equal to the width of the patient's hand at the level of the head of the metacarpal bones. For small defects of level I, flaps from the medial and lateral heads of the gastrocnemius muscle used, flaps from the medial half of the soleus muscle were used for level II and III; the gastrocnemius fasciocutaneous distally attached (sural) flap was used for level IV and V. Clinical observation of such tissues use is shown in Fig. 4. In the presence of a defect area of more than 0.5% b.s. complex reconstruction of the tissues from the serratus anterior, latissimus dorsi and lateral vastus muscle. Clinical observation of the use of a flap from the lateral vastus muscle to replace the soft tissue defect of the lower leg is shown in Fig. 5



Fig. 4. Restoration lower leg integumentary tissues with a sural flap as preparation for internal fixation: a — the X-ray image of a patient with an open comminuted fracture of both bones of the left lower leg in the lower third; b — the integumentary tissue defect of the lower leg fracture region; c — the lower leg on the 10th day after moving the flap; d — the X-ray of a patient on the 2nd day after the removal of the external fixation device and performing the final internal plate fixation



Fig. 5. The use of a free flap from the vastus lateralis to replace the defect of the left lower leg soft tissues: a – the defect of the left lower leg soft tissues; b – the wound 4 days after replacement of the defect with a free revascularized flap of the vastus lateralis; c – the donor site on the left thigh; d – the lower leg 4 months after the defect replacement

RESULTS

According to the results of the study, the incidence of necrosis of the underlying structures, such as tendons, articular surfaces, bone fragments, was 18.8% in the group with improved tactics (55.1% in the comparison group). We explain these data by the fact that in the study group the displaced blood supply complex of tissues prevented drying out of exposed structures, contamination with microorganisms, and also became a source of blood supply for the damaged area.

In the study group, we noted reduction in the incidence of deep wound infection, 23.1% versus 36.7% in the comparison group. In our opinion, these results indicate that restoration of the cover when moving the vascularized tissue complex goes according to the type of primary healing (bypassing inflammation and exudation). Also, the displaced flap prevents further contamination by microorganisms and death of underlying structures, which reduces the likelihood of purulent-necrotic complications. Fig. 6 shows the primary healing of the stump wound of the shoulder after closure with a free perforated anterolateral graft.

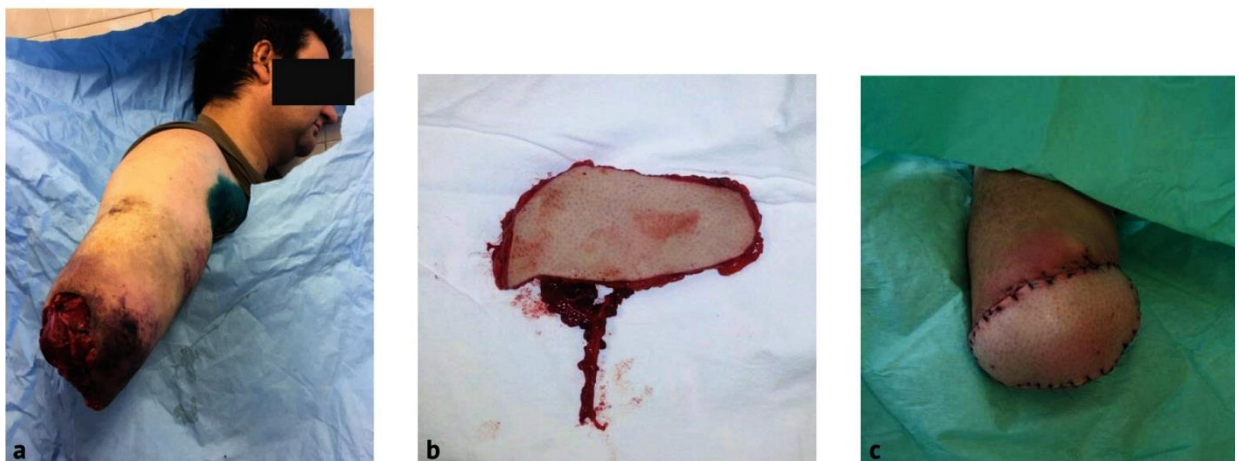


Fig. 6. The replacement of the shoulder stump frontal defect with a free perforated anterolateral graft: a – the soft tissue frontal defect of the right shoulder stump; b – the anterolateral perforated flap prepared for autografting; c – the right shoulder stump on the 5th day after restoration of integumentary tissues with the anterolateral perforated flap

The incidence of chronic infection such as osteomyelitis in the study group was 11.6% (28.6% in the comparison group), which we explain by preventing the development of bone necrosis, the main pathogenetic factor of chronic osteomyelitis.

The frequency of development of adjacent joints contractures with the use of improved tactics for replacement of defects in integumentary tissues was 34.8% and 53% after traditional treatment. We associate these results with a less significant development of the scar process (due to primary healing) and earlier rehabilitation of the patient.

Patients who were treated with improved treatment tactics stayed in hospital for a shorter time — 66.7 ± 10.7 days (81 ± 17.4 days in the comparison group). We explain this by the fact that when the defect is closed with a full-

thickness flap, a long stage of local wound treatment is excluded, and the frequency of complications requiring long-term treatment decreases.

DISCUSSION

Restoration of adequate skin is an integral part of limb reconstruction after severe injuries [7]. If the problem of restoring soft tissues is not solved and there are non-healing wounds, it leads to chronic wound infection, bone loss and violation of fracture consolidation [8]. In patients with severe limb lesions after high-energy trauma, a tactic of local wound treatment followed by autodermoplasty after wound filling with granulation tissue was performed [9]. The undeniable advantages of this tactic is the safety for the patient, because it is not required to perform large reconstructive interventions, and the relative simplicity of using this technique for a doctor, since specialized skills for the movement of blood-supplying tissue complexes and specific instruments are not required [10]. Despite widespread adoption, this tactic of treatment has very significant drawbacks [11].

First, the shortcomings include the duration of integument tissues restoration, which is at least 21 days from the time of injury, tendon tissue or bone tissue is exposed, this time grow up to several months, as shown in our study. Secondly, a significant disadvantage of local treatment tactics with subsequent autologous plastic surgery is that the reconstructed skin is imperfect, scar-altered. This skin can not carry a load, for example, on the supporting surface of the foot or stump of the lower limb. It restricts movements in adjacent joints, it is impossible to perform repeated reconstructive operations through this skin because of poor healing of the incisions made through the scar tissue. Prolonged use of the local treatment method leads to death of the exposed tendon or bone tissue, which requires the removal of extensive areas, and its incomplete removal may result in chronic wound infection [12]. The shortcomings of the tactics of local treatment with subsequent autodermoplasty of traumatic defects in the limbs soft tissues, which are based on the literature, are fully confirmed by the data of our study.

The transfer of vascularized tissue allows early restoration of the full skin in the area of the defect to be performed [13]. However, in order to perform these interventions, it is necessary to have specific skills, microsurgical instruments, and (in the case of free flaps) an operating microscope. Surgical interventions with vascularized tissue complexes are associated with large surgical incisions and blood loss [14]. They can also be quite long, especially when free revascularized flaps are used. At the same time, early restoration of a full-thickness skin prevents the development of deep wound infection and necrosis of underlying structures, such as bone and tendon tissue. Limitation this tactic is that with its help it is completely possible to close the defect with an area of up to 1% b.s. (approximate maximum area of transferred tissue).

One-stage replacement of integumentary tissues defect with a vascularized flap requires stabilization of hemodynamic parameters of a patient and the choice of the proper timing depending on the mechanism of injury and the severity of the patient's condition [14]. This task is solved by the algorithm developed in our clinic. Another important issue is the tissue composition of the applied flap [15]. In the literature, the use of muscle grafts for restoring integument tissue in traumatic defects of soft tissues is discussed [16]. These flaps have good sanitizing properties, are very plastic, can replace soft tissue defects of various sizes and shapes. On the other hand, on the surface of muscle grafts, autodermoplasty is necessary. Thus, the transfer of the muscle flap does not restore a full cover, since there is no subcutaneous fat tissue. This limits the possibility of repeated operations through the surface of the muscle flap, restricts the movement of the joints, and the skin restored with a muscle flap, is less tolerant to loads.

Fascioutaneous flaps is a method of restoring a full-thickness tissue, which includes subcutaneous fat tissue, fascia and skin [17]. However, they are much less plastic and require a more accurate marking of the flap before transposition. Currently, fasciocutaneous flaps are the main method of repairing integumentary tissues and are used in combination with the underlying muscular tissue and isolated on perforating vessels [18].

CONCLUSION

As a result of the study, a tactic of primary closure of defects in integument tissues of extremities with vascularized tissue complexes (flaps) was developed. This complex of medical measures allows you to choose the optimal time for reconstruction, determine the best method of restoration, depending on the severity of the patient's condition, location and defect area.

FINDINGS

Patients who have been treated with vascularized tissue complexes have a lower incidence of complications than patients who have been treated with traditional local treatment followed by autodermoplasty. Wound infection decreased by 13.6% necrosis of exposed functional structures in the defect decreased by 36.3%, chronic osteomyelitis decreased by 17%, the frequency of contractures of adjacent joints decreased by 18.2% and the duration of treatment decreased by 14.7 days.

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