OPTIMIZATION OF THE SURGICAL TREATMENT IN REPLANTATION OF EXTREMITY SEGMENTS

The article discusses the problem of replantation of extremity segments in different trauma mechanisms. While studying the outcomes of the replantation operations for full or partial amputation of limbs or their segments in the 495 patients (363 men, 132 women) the dependency on conditions and duration of their transportation, adequacy of shock actions, anaesthetic provision, and correctional treatment after the operation is determined. Replantation and reconstructive operations were performed in 191 cases, of them in 7% replantation of big segments. Simultaneous traumatic amputations of two and more segments were noted in 54 cases. Extended skin and soft tissue defects were found in 9 patients. Good outcomes were noted in 77.2% of cases. As Bogomolov and Sedov (2003) showed, a direct relationship was revealed between the anoxia period and the rate of arterial thrombosis.

**Keywords:** Amputation of the limbs, improvement aid, replantation, correctional treatment.

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**Introduction**

The traumatic loss of large segments of the extremities is one of the most severe types of injury resulting in hard disability. Raising its frequency over the last decades is connected with continuous growth of mechanization in the sphere of industry and daily round activity. As the global development shows the number of patients with this pathology is decreasing in the developing countries. However, the frequency of amputations of the extremity segments remains to be high. While in the past the patients with so called guillotine amputations prevailed, the character of injuries in the present time has changed with tendency of their complexity increasing (Abalmasov, Garelik, 1998; Kurbanov et al., 2002).

In some cases, precise evaluation of surgical treatment prospects may help patient to avoid prolonged microsurgical operation and rehabilitation which lead to healing of viable but functionally useless segment of extremities.

Considering this, it is very important during the preoperative stage to determine acceptable scale of operations with reference to the general condition of patient (hemodynamic stability, anemia, accompanied pathology and others). The general contraindications to replantation include marked symptoms of cardiopulmonary or hepatic insufficiency, traumatic shock of stage III, diabetes mellitus and others.

In case of absence of common contraindications, the analysis of the state of each separated segment is performed on the basis of character and durability of trauma, storage and delivery situations. Freezing of the separated fragment to the state of glaciation is the absolute contraindication to the replantation procedure. Presence of significant tissue lesions of the separated fragment, exceeding the permissible terms of anoxia appear as relative contraindications for replantation.

The experimental studies on animals have shown that histological changes in the tissues, which had ischemia, were detected only in early period after limb replantation. In the remote period after replantation there were detected histological changes specific to denervated tissues (Povslen et al., 1995; Moras and Berger, 2003).

Apparently, the factor limiting success of replantation is not the biological death of tissues
of the amputated fragment, but the changes occurring in its vessels because of ischemia development. This opinion find its prove in experimental studies, which showed that already after 6 hours of hot anoxia in the amputated fragment there were developing microcirculation disorders such as stasis and decreased blood flow in the microvessels (Povslen et al., 1995; Papanastasiou and Soud, 2002).

Important to note that high-grade restoration of blood circulation in replants in the long-term period after operation is recorded during a replantation of various quantity of vessels and during reconstruction of vessels with various methods (Papanastasiou and Soud, 2002; An et al., 2003). Though, the vessels anastomosed during replantation continue to function not in all cases in the remote postoperative period (Povslen et al., 1995). All this forces us again to return to consideration of the problem of limb segments replantation.

**Materials and methods**

In the Republican Research Centre of Emergency Medical Care in the Department of vascular surgery and microsurgery in the period from May 2000 till September 2004 394 patients with complete and incomplete traumatic amputations of limb segments were treated.

The age of the patients (313 males and 81 females) varied from 1.5 years of age to 50 years of age (range 1-10, n=102; range 11-20, n=103; range 21-30, n=95; range 31-40, n=71; range 41-50, n=23). The majority of patients were people of active working age.

**Results and discussion**

In calculation of time frame required to execute replantation one should use not the maximum but the minimum time of ischemia and to remember a rule - minus 3h: 3 hours is a time from the moment of delivery of the patient to the centre before full inclusion of tissues into blood flow.

It is necessary to note that in incomplete amputations the cooling of amputated segment at the prehospital stage was not carried out (in such cases there was only ischemia). Completely amputated fragments, after admission into the clinic, were placed into a refrigerator till the beginning of surgical manipulations (i.e. not less than 2-3h they were being cooled up to +4 C.) In such cases it is relevant to mention about the period so-called mixed anoxia.

The complete amputations of the limb segments were observed in 224 (56.9%) patients, incomplete - in 170 (43.1%). Large segments were in 22 patients (5.6%). The large segments were considered beginning from the level of hand and higher, i.e. those comprised of muscular tissue.

Depending on the trauma mechanism there was noted a simultaneous injury of one segment at two and more levels (21 men) or amputation several segments (54), which required individual tactics in each concrete case. Amputation at a level of shoulder were noted in 3 (0.8%) cases, forearm - in 4 (1.0%), hand - in 6 (1.5%), block of fingers - in 9 (2.3%), basic phalanx - in 59 (15.0%), middle phalanx - in 101 (26.6%), ungual phalanx - in 212 (53.8%),

Only in 191 (48.5%) patients there was an opportunity to perform replantation or either kind of reconstruction. In 203 (51.5%) cases owing to mistakes at the prehospital stage the performance of reconstructive operations was impossible because of absence of the amputated segments (123; 31.2%) or their wrong delivery (80; 20.3%). The segments mostly were delivered in water or were wrapped up in a cloth (cotton wool) or cellophane. The required temperature mode in the most cases was not observed. When segments properly transported and duly delivered the probability of success of operation considerably grew. After stabilization of hemodynamic parameters and estimation of the stumps and segments, there were replanted 7 from 22 large segments and 123 from 169 small segments.
Example of the large segment replantation. The patient А., 32 years. The diagnosis: complete traumatic amputation at a level of the upper third of left shoulder. Two hours before admission his hand was pressed down by the edge of a concrete plate at the building. The patient was delivered by car after rendering the first care at the place of incident.

The general health state of the patient was heavy. Arterial pressure was 90/60 mm Hg. Actually there was complete amputation of the left hand at a level of the upper third of the shoulder with preservation of only narrow (3 cm) skin bridge on the back surface of the shoulder. There was no blood circulation in the segment. Soft tissues in the field of the wound are crushed; there is a bridge of skin damage of width up to 2 cm on the stump and segment.

The roentgenogram indicated on comminuted fracture of humerus. The segment has no visible lesions. After revision of the skin bridge, not containing structures, was crossed, and the segment was washed carefully in furacilline and placed in a refrigerator at the temperature +4 °C.

The measures against shock have been performed. After stabilization of the patient’s state was performed a revision of structures on the stump and amputated segment. After dissection of the crushed muscles and inflamed skin margins, removal of free bone fragments there was performed intramedullary osteosynthesis with a pin of Elansky with additional fixation by a steel wire. Then was performed the connection of the ends of the biceps, triceps and humeral muscles by Π-shaped sutures with a vicryl thread. After that, the arterial anastomosis of brachial artery was made end-to-end with the thread of 6/0 prolene with start-up of blood flow without vein restoration and perfusion of the segment with blood during 5-6 minutes. This helped to wash out small blood clots from vascular bed and products of disintegration from ischemized tissues. The total period of ischemia of a segment from the moment of trauma to starting of blood flow was 4 hours. Only after that was made anastomoses of two veins with central sutures with the thread 6/0 prolene with complete restoration of normal blood circulation in the limb. Epiperineural sutures were made on the median, elbow, radial and skin-muscular nerves with thread 8/0 with central sutures under magnification by 8 times. Postoperative development was without complications. The massive infusion therapy with introduction of antibiotics, anticoagulants, spasmylytics and remedies improving rheology and microcirculation was performed.

There was achieved a complete viability of replanted limb with healing of a wound by primary tension. The patient was discharged on the 8th day for continuation of treatment in the physiotherapy clinic.

The successful outcomes were marked in 112 out of 145 (77.2%) patients, who underwent the restoration of limb, though the percentage of successful procedures was different for complete and incomplete amputations. So, after replantation of complete amputations the good results were noted in 18 (62%) patients out of 29, of incomplete - in 94 (81%) patients out of 116. These parameters meet the data of the world literature.

The complete necroses of replanted segments in complete and incomplete amputations of small segments in the postoperative period were recorded in 18 (12.4%) cases. In 15 (10.3%) patients the reason of necrosis was primary thrombosis of arterial anastomoses; in 3 (2%) patients - thrombosis of arterial anastomoses after developed venous block in the closed damage of the back veins. In 24 (16.5%) cases took place regional skin necroses (19; 13.1%) and wound suppuration (5; 3.4%) caused by inadequate primary surgical processing.

Analysis of complications indicated on the direct correlation between duration of the period of anoxia and increase in frequency of arterial thrombus development. The mechanism of influence of anoxia duration on direct results of replantation of various by volume fragments of the limb can be presented as follows. Exceeding critical period (8-10 hours) of the thermal anoxia in the vessels of amputated fragments leads to development specific changes manifested during blood circulation restoration in these vessels by microcirculation disturbances (a consequence of endothelium ischemic lesion) and edema of replanted segment tissues (a consequence of increase of vascular wall permeability and lymphostasis). The developing edema results in increase of pressure in the replant tissues and crushing of its vessels, aggravating frustration of microcirculation, induced by ischemic lesions of endothelium. The critical decrease in blood flow causes thrombosis of
arterial or venous microanastomoses.
Besides, the restoration of blood circulation in the tissues, which were in anoxia for a long
time, is dangerous by the development of common complications connected to entering
into blood of toxic products from replanted limb, i.e. the phenomenon similar to the
syndrome of prolonged squeezing. Intensity of manifestations of this syndrome depends
on the durability of anoxia; degree and extent of crushing of tissues of the suffered limb,
and on the volume of replanted segment, first of all, on the volume of muscle tissue
included into its composition.

The decrease of tissue resistance induced by prolonged ischemia and resulting in the
development of wound complications plays not a last role.

Conclusions

1. The successful performance of replantations is possible only when patients and
amputated segments are timely and properly transported to clinic.
2. Timely admission of patients into specialized medical establishment, competent
conduct of antishock measures reduce the period of ischemia of amputant, widen the
indications for replantation, increase the percentage of segments healing without
rejection and good long-term functional results.
3. The specialized reanimation-anesthesiological care directed to the improvement of
blood rheological properties, removal of peripheral spasm, improvement of tissue
metabolism of the replanted segment is of great importance.
4. For the achievement of optimal final result several operative interventions may be
required, so the dynamic supervision is necessary over the patient during all the period
of his recovery.

References

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