

Demonstration of the possibilities of reconstructive surgical interventions for closure of the exposed bones of the facial skeleton and cranial vault due to extensive defects of various etiologies

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Introduction Surgical treatment of patients with tissue defects of the scalp and face is challenging for surgeons. It is an integral part of the social and labor rehabilitation of such patients. Exposure of the skull bones after extensive polyetiologic resections creates a difficult task for reconstruction of complete or partial loss of soft tissues of the head. Autologous dermoplasty, simple in its technical implementation, is impractical on the bones of the facial and cerebral skull because insufficient vascularization of the wound bed creates a risk of early rejection of the graft. The aim of the study was development and evaluation of the effectiveness of the method of restoring the integrity of the skin of the head and face in extensive defects with exposure of the bones of the skull. **Materials and methods** Analysis of the methods and results of reconstructive surgical treatment of three patients with extensive defects in the tissues of the scalp and face at the Research Institute of the Ochapovsky Regional Clinic Hospital No.1 in 2018-2020. **Results** The immediate result of surgical treatment was a complete restoration of the skin with the maximum possible preservation of underlying deep anatomical structures after a radical one-step removal of non-viable tissues, both soft and bony. Subjectively, the patients were satisfied. The aesthetic result obtained in all cases satisfied both the patients and the surgical team. **Conclusion** The treatment of extensive defects of the soft tissues of the face and bones of the skull is a doable task, provided certain conditions are met. Removal of the affected tissues with simultaneous plasty of the resulting wound defect with an autologous greater omentum and skin autografts allows one to simultaneously solve the problem of plastic closure of wound defects of such localization. When performing osteonecrectomy of the outer cortical plate of the skull to the bleeding layer, conditions are created for survival of a free skin autograft on the bone.

Keywords: wound, head, skull, face, greater omentum, plastic autodermoplasty, vacuum system, wound covering

INTRODUCTION

Soft tissue defects of in the face and scalp after resections in oncological cases or due to injuries (burns) still remain one of the most challenging problems in contemporary reconstructive surgery. It is mostly associated with a significant spread of both oncological processes of the skin and burn injuries. Burns can be called a current traumatic epidemic in densely populated cities and industrialized countries of the world. According to the WHO, burn injuries rank second or third among other types of injuries, while skin cancer occupies a leading position in terms of morbidity in many countries of the world. Extensive wound defects are formed due to deep burns and head injuries, resection of tumor lesions of the skin. If deep anatomical structures remain intact, it is considered optimal to perform skin grafting with a full-thickness flap [1–4]. In case of total facial defects, facial transplantation has been performed since 2008 [5].

About 150 years have passed since the first free autologous dermoplasty was performed by Jacques

Reverden, and this technique continues to be improved in our time [6].

Reconstruction of the skin in extensive head wound defects with preservation of soft tissues is possible due to autologous dermoplastic wound closure with both a full-thickness autologous graft (Krasovitsov's plasty) and a split autologous graft. The method of wound vacuum therapy has found wide application in surgical treatment of wound defects of various etiology and localization [7, 8].

A large number of poor outcomes in surgical treatment of patients with extensive defects of the scalp is due to the fact that free autologous flaps do not survive on the bone [9]. Extensive wound defects of the scalp with the loss of soft tissues and the bony bottom of the skull wound need a staged surgical treatment. Cuts are produced on the bone tissue to a bleeding layer for further formation of granulation tissue within six months. Next, a delayed autologous dermoplasty is performed on the granulating wound [4].

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If deep anatomical structures of the face and scalp are exposed, one of the methods of choice is plastic surgery with a greater omentum on a vascular pedicle followed by autodermoplasty [10–13]. In order to achieve positive functional and cosmetic results of surgical treatment, it is optimal for patients with deep wound defects in the facial area to perform plastic surgery with a full-thickness autologous cutaneous flap transfer.

A method of surgical treatment of patients with extensive head wound defects with exposure of the skull bones was developed at the Ochapovsky Research Institute and Regional Hospital # 1 [14].

Purpose of the study To develop a method of surgical treatment of extensive wound defects of the head in the acute period after injury to improve the reconstruction of the skin in head wounds, reduce the time, create conditions for survival of a free autologous flap on bone tissue, ensure uniform dense pressure on the autologous flap in skin grafting, improve functional and cosmetic treatment results. To substantiate the use of a greater omentum for reconstruction of extensive wound defects of the scalp and face, to improve the results of surgical treatment of patients with extensive defects of the head soft tissues of various etiologies by choosing the optimal reconstructive method.

MATERIAL AND METHODS

We present three clinical cases of surgical treatment of patients with extensive defects of the face and scalp of various etiologies. The development of the techniques was carried out in accordance with the Declaration of Helsinki of the World Medical Association "Ethical Principles for Medical Research Involving Human Subjects"

as amended in 2000 and the "Rules of Clinical Practice in the Russian Federation" approved by the Order of the Ministry of Health of the Russian Federation dated June 19, 2003 No. 266. The patients gave their voluntary informed consents to the publication of their cases in the open media.

RESULTS

Case 1 Female patient P., 35 years old, diagnosed with concomitant trauma, extensive post-traumatic head wound of 1,000 cm² (Fig. 1a). Surgical treatment was performed three days after the injury upon stabilization of her general condition. The patient underwent surgical treatment of the wound surfaces including cuts with a scalpel at the border of intact skin and granulation tissue of facial wounds; the altered edges of the wound bed were economically excised, and areas of non-viable tissues were tangentially excised. Hemostasis was performed by electrocoagulation and pressure bandages with adrenaline solution. Next, in the area of osteonecrosis, using an oscillating saw, we produced mutually intersecting cuts at an angle of 90° to equal depth at equal distances of 1–1.5 cm to the bleeding layer (Fig. 1b). A chisel was used for osteonecrectomy within the viable inner cortical plate of the calvaria bones (Fig. 1c). Guided by the size of the wound defect, a D-100 electrodermatome was used to collect three split thick autologous cutaneous flaps (0.8 mm thick). The D-60 electrodermatome was used to collect six split autologous cutaneous flaps (0.3 mm thick). The donor wounds in the area of collection of thick autologous cutaneous flaps were covered with perforated autologous cutaneous flaps

(0.3 mm thick with a perforation index of 1:4). "HitoPran" wound closure was applied over the performed autodermoplasty. On the surgically treated wound surfaces in the facial area, plasty was performed with autologous cutaneous flaps (0.8 mm thick). The edges of cutaneous autografts were sutured with the edges of the wound bed by upholstered continuous edge-to-edge stitching. Surgically debrided bone defects in the scalp were reconstructed with perforated autologous cutaneous flaps (0.3 mm thick with a perforation index of 1:2), which were fixed to the edges of the wound bed with interrupted sutures (Fig. 1d). Next, these areas were closed with mesh atraumatic covers and the vacuum system with certain operating parameters of the apparatus of negative pressure (110 mm Hg) (Fig. 1e) was applied. On the 5th post-operative day, the vacuum dressing system was removed (Fig. 1f). On the 8th day, the dressing was applied (Fig. 1g). On the 12th day, the next dressing was changed and the dressings on the epithelialized donor wounds were removed. On the 14th day, the last dressing was performed, which showed a complete adaptation of the autologous cutaneous grafts (Fig. 1h). The patient was discharged from the hospital. Good cosmetic and functional results were observed three months after discharge (Fig. 1i).



Fig. 1 Patient P., 35 years old: *a* extensive post-traumatic wound with osteonecrosis of the bones of the cranial vault; *b* osteonecrectomy of the skull bones; *c* bottom of the wound after surgical debridement; *d* autodermoplasty of the resulting wound defect; *e* functioning vacuum system on the head; *f* first dressing, 5th day after the operation, the vacuum system has been removed; *g* on day 8 after autodermoplasty; *h* 14th day after autodermoplasty, view at discharge; *i* 3 months after discharge

Case 2 Patient M., 68 years old, had a one-month history of electric burn. In the delayed period, the patient was transported from the neighboring region to the Ochapovsky burn center where, after preoperative examination and preparation, he underwent an operation performed by a multi-team of surgeons. The patient had extensive post-traumatic necrosis of the soft tissues in the occipital region with destruction of the underlying bony structures of the cranial vault (Fig. 2a). Contusion of the underlying dura mater was the reason for rejection of free cutaneous flap and the choice of re-vascularized omental autograft as a plastic material for closing the defect. The simultaneous work of two teams of surgeons in the donor and recipient areas enabled to reduce the duration of the operation. While vascular surgeons performed a laparotomy and mobilized the greater omentum, burn repair surgeons performed soft tissue necrectomy and osteonecrectomy of the bony structures of the cranial vault, maintaining the integrity of the dura mater (Fig. 2b).

After mobilization of the autologous graft and preparation of the defect for reconstruction, the recipient vessels of the neck (facial artery and vein on the homolateral side) were dissected, and a bed was formed in the soft tissues of the parotid region for the vascular pedicle. A team of vascular surgeons performed end-to-end microvascular anastomoses between the facial vessels of the neck and the left ventricular-omental vessels of the autograft. The re-vascularized omental autograft was placed in the defect bed in the occipital region, fixed to the edges of the defect with interrupted absorbable sutures (Fig. 2c). Autoplasty was performed on the omental autograft with split cutaneous flaps, 0.3 mm thick, taken from the patient's thigh using a dermatome, and fixed to the edges of the defect skin with a continuous twisted suture (Fig. 2d). Such an algorithm of reconstruction achieved a positive functional and aesthetic result (Fig. 2e) already on the 14th day of the postoperative period. Due to the asocial lifestyle of the patient, it was not possible to assess the long-term outcome.

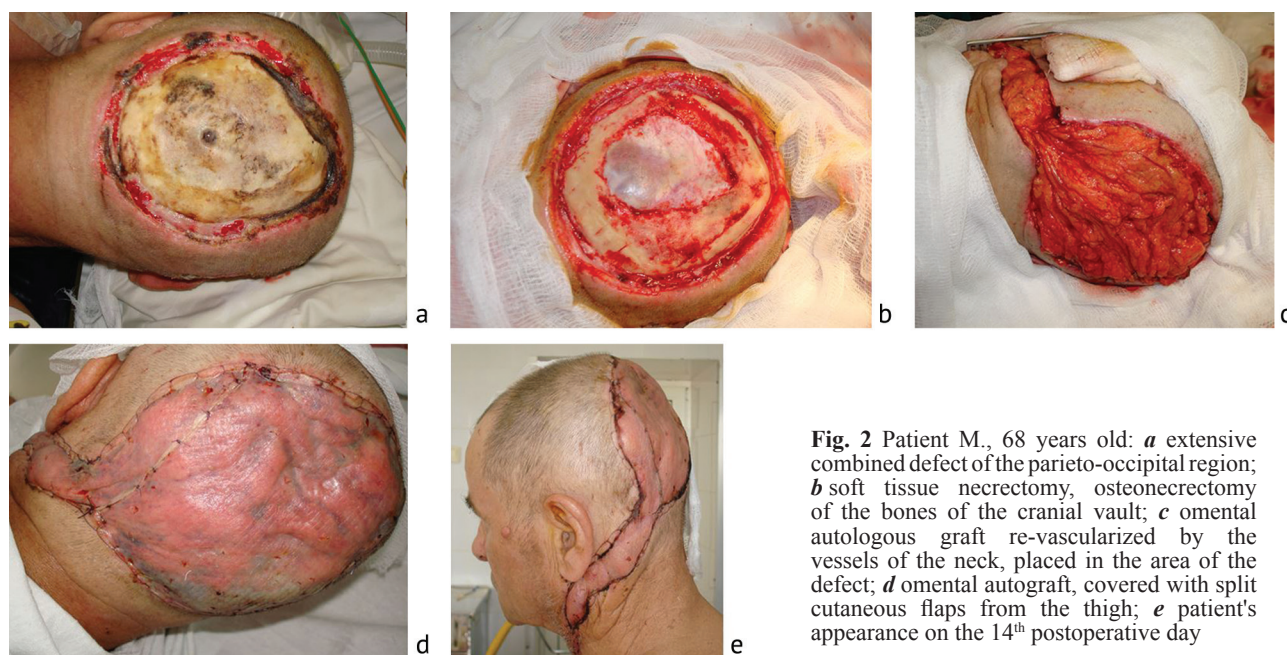


Fig. 2 Patient M., 68 years old: **a** extensive combined defect of the parieto-occipital region; **b** soft tissue necrectomy, osteonecrectomy of the bones of the cranial vault; **c** omental autologous graft re-vascularized by the vessels of the neck, placed in the area of the defect; **d** omental autograft, covered with split cutaneous flaps from the thigh; **e** patient's appearance on the 14th postoperative day

Case 3 Patient G., 65 years old, with tumor process of the skin behind the ear for 5 years. In a specialized oncological institution after morphological verification (PGI keratinizing squamous cell carcinoma) and diagnosis of skin cancer of the behind the left ear region T₂N₀M₀ II st., II class. gr. Distance radiation therapy was performed with SOD 56 Gy. Later, due to residual tumor and tumor destruction of the temporal bone, the patient was recommended to carry out symptomatic treatment at the place of his residence (Fig. 3a). After 2 years of dressings with ointments, an increase in the size of an ulcerated tumor and pain, the patient applied to asked the Ochapovsky Research Institute, where in the surgical department No. 3 (maxillofacial surgery), after additional examination and preoperative preparation together with a team of neurosurgeons, the patient underwent surgical treatment including amputation of the auricle and excision of the soft tissue tumor in the parotid temporal region, subtotal petrosectomy, preventive modified cervical lymphadenectomy of the third type, reconstruction of the defect in the parotid region and the base of the skull with a musculocutaneous pectoral flap.

The intervention was carried out with the participation of two teams of surgeons, neurosurgeons and maxillofacial surgeons and included also an oncologist and a plastic surgeon. Removal of the tumor with a neurosurgical stage and mobilization of the musculocutaneous pectoral flap with a preserved nutrient vascular pedicle were performed simultaneously and reduced the time of surgical intervention. However, lymph node dissection was performed after removal of the tumor and mobilization of the flap as simultaneous work of the oncologist on the structures of the neck with rigid fixation of the head by neurosurgeons, insufficient surgical space required for simultaneous work of two teams of surgeons on the structures of the fornix and base of the skull and soft tissues of the neck was impossible. After removal of the soft tissue component of the tumor

and amputation of the auricle, subtotal petrosectomy was performed (Fig. 3b).

An extensive combined defect of the parotid-temporal region, the bottom of which was the dura mater, pronounced concomitant cardiac and endocrine pathology, forced us to face the choice of a flap, which is characterized by extreme reliability and the speed of its cutting. Such a plastic material, from our point of view, is a musculocutaneous pectoral flap with the preservation of the feeding thoracoacromial vessels (Fig. 3c), and its transposition into the defect area in the skin tunnel on the neck led to a decrease in scars and, as a consequence, to an improvement in aesthetic results (Fig. 3d, 3e). The study of the resection margins with the obtained intraoperative and planned pathological index Ro, the absence of metastatic lesions of the lymph nodes of the neck pNo suggests a favorable outcome of the oncological process in the long-term period.

The postoperative period from the side of autodermografts, both split cutaneous and re-vascularized omentum in all the above patients, proceeded without complications. No manifestations of ischemia or venous insufficiency, subsequent necrosis of the omental autologous graft were observed, and no rejection of autodermografts on the bone tissue of the skull was observed either. No complications were observed at the sites of donor autodermograft collection. Drains from the abdominal cavity were removed on the 4th day of the postoperative period, laparotomic wounds healed by primary intention, the collection sites of split autografts healed by secondary intention.

The direct result of surgical treatment was complete restoration of the skin with the maximum possible preservation of the underlying deep anatomical structures after a radical one-step removal of non-viable tissues. The patients expressed subjective satisfaction. The aesthetic result obtained in all the cases described above was evaluated satisfactory by both patients and surgeons. It should be noted that,

despite various etiological factors, the depth and area of the wound defect that had to be closed by a surgical

method played a decisive role in the choice of the treatment methods described.

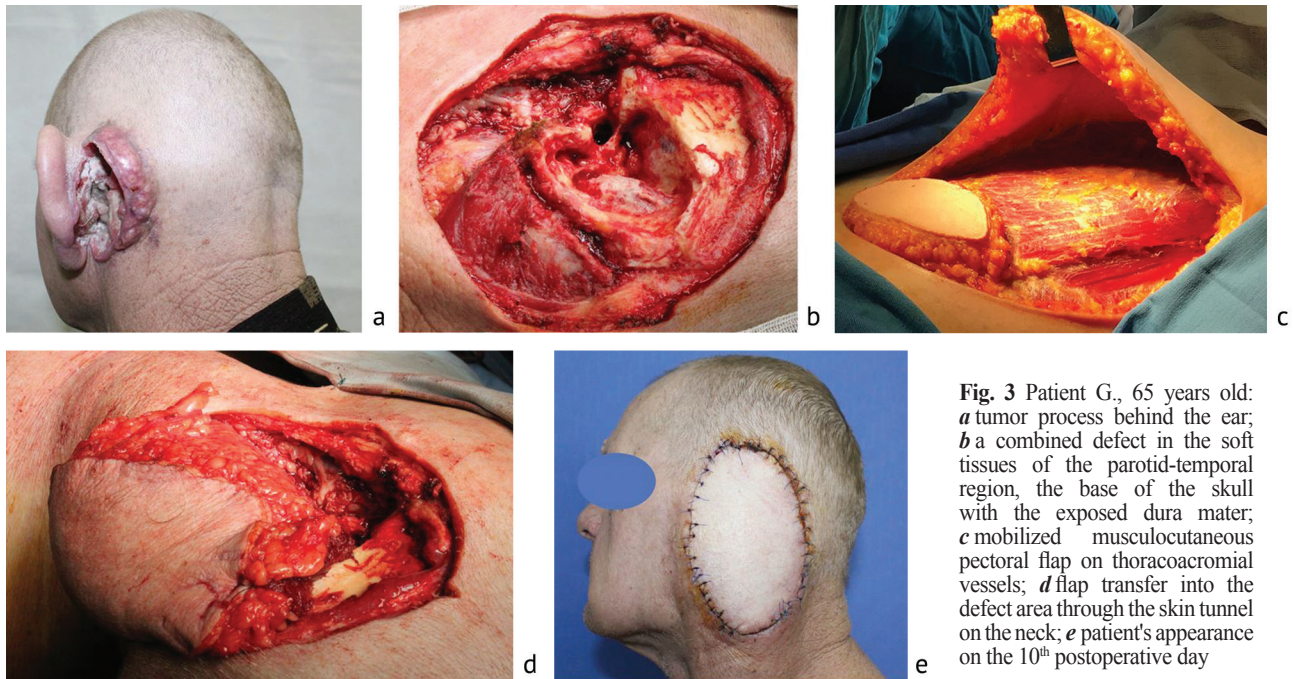


Fig. 3 Patient G., 65 years old: *a* tumor process behind the ear; *b* a combined defect in the soft tissues of the parotid-temporal region, the base of the skull with the exposed dura mater; *c* mobilized musculocutaneous pectoral flap on thoracoacromial vessels; *d* flap transfer into the defect area through the skin tunnel on the neck; *e* patient's appearance on the 10th postoperative day

DISCUSSION

Technical difficulties in the reconstruction of extensive defects of the scalp of various etiologies are associated with a deficiency of soft tissues in this area, inability to use local and transferred flaps due to their small size, inflammation in the surrounding and underlying tissues. Extensive combined defects of the scalp, the restoration of which is difficult or impossible with local and regional flaps, are reconstructed with re-vascularized autologous grafts. Most often, such autologous grafts include the forearm radial flap, the latissimus dorsi muscle, the rectus abdominis muscle, and the anterolateral thigh flap [15–17]. Each of the above flaps has its own pros and cons, while the choice of the reconstruction method depends on many factors of a unified whole issue: the area of the defect, the length of the vascular pedicle, the area and thickness of the graft, the morbidity of the donor bed, hospital equipment and training of the team of surgeons.

Omental autograft has been described less often in the world literature for the reconstruction of scalp defects, although the omentum is often used in various fields of surgery for its transplantation to the required location [18–20]. It meets all the criteria for the reconstruction of extensive defects of the scalp. It is able to cover defect areas of more than 200 cm², has a low morbidity of the donor bed, the vascular pedicle corresponds to the size of the vessels of the facial artery and vein, and the length allows re-vascularization both on the face into the superficial temporal vessels, and on the neck into the vessels of the external carotid artery and facial vein system. An important feature of the omental autograft is its adhesive ability, which allows its use in defects of the scalp, bordering on foci of chronic inflammation of both soft tissues and skull bones. The greater omentum has

been used in our clinic as an autologous graft for burn injuries and oncological cases, has established itself as an autograft of choice. The method of its use has been described in detail by both domestic and foreign authors.

Upon a complete examination of patients, the tactics of surgical one-stage reconstruction of defects of the scalp and face was determined at a multidisciplinary medical council with the participation of the heads of the departments of the burn center, maxillofacial surgery, oncology, neurosurgery, vascular surgery, traumatology, the department of anesthesiology and resuscitation. The entire surgical process and the rehabilitation period took place under the supervision of the aforementioned specialists. Microflora and antibiotic sensitivity of the ulcerated surface of the defects was studied in the preoperative period.

Surgical treatment of a patient with osteonecrosis of the bones of the cranial vault according to the developed technique enabled to restore the skin on the skull in the first week after the injury, in contrast to the traditional staged surgical treatment for exposed skull bones which is carried out for six months, aimed at the growth of granulation tissue along the bone demarcation zone, requiring the production of cuts to the bleeding layer, often resulting in osteomyelitis and necessity of dressings and supervision of specialists for a long time. The application of parallel cuts on the skull at a distance of 1–2 cm down to the bleeding layer determines the viable bone tissue, on which free autologous cutaneous plasty can be performed, but also serves as the optimal technique for performing osteonecrectomy for one thickness of the skull.

It is optimal to perform CT, MRI or radiography of the skull prior to surgery for all patients to determine the thickness of the bone, to clarify the

extension of tumor and osteonecrotic processes. The instrumental study contributes to the optimization of the intervention technique, serves as a determinant

for preventing exposure of the dura mater in osteonecrectomy or its resection in the case of an invasive type of tumor growth.

CONCLUSIONS

Integrity of the skin in extensive defects after oncological resections, trauma or burns often cannot be restored with local tissues or regional flaps. Surgical interventions of much volume should be performed in multidisciplinary clinics with developed surgical, anesthetic, neuroresuscitation and rehabilitation services. Primary free autodermoplasty after osteonecrectomy of the skull to the bleeding layer of bone tissue may yield positive results in the early stages after injury. Creation of uniform pressure on the cutaneous graft in the wound due to the use of a vacuum wound closure system promotes rapid adaptation and its complete survival. Skin plasty with an autologous full-thickness cutaneous flap

on the face requires an additional autologous graft to close the donor site, but in the long-term period reaches the maximum cosmetic result on the face. Reconstruction of extensive combined defects of the scalp and face with the need for craniotomy and resection of the bones of the facial skeleton is a task requiring the coordinated work of a multidisciplinary surgical team consisting of maxillofacial surgeons, oncologists, neurosurgeons, vascular surgeons and ophthalmologists. The best option for the closure of such defects is one-stage reconstruction with a revascularized omental autologous graft, which enables to obtain an optimal immediate and subsequent satisfactory cosmetic result of the operation.

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