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Use of TiNi-based Alloy Implants in Repair the Zygomatic Bone and Arch

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Abstract

The article presents a technique of replacing total defects of zygomatic bone with implants from nickelid titanium in combination with thin-profile netlike nickelid titanium and three cases. In all the patients, a satisfactory functional and cosmetic result was achieved.

1 Introduction

Total defects of zygomatic bone and arch can be a result of both traumatic injuries when in multifragmental fractures during initial surgical d-bridement of the wound all free bone fragments are removed, and tumorous injuries of the mentioned parts of the facial skull. Nowadays elimination of such defects presents a challenge due to configuration, spatial location of the defect, expressed scar changes in the tissues of zygomatic, parotid-masticatory and suborbital regions. To restore the lost osteal structures in such category of patients, the use of allogeneic and free autologous bone grafts is not reasonable because of their rejection and/or resorption. Implants made from chromium-cobalt steel, titanium, vitallium, silicon, biopolymer, carbonaceous and other materials (without lagging effect, i.e. which are not biocompatible) [10] after

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insertion into tissue defects either reject or behave like foreign bodies, which no doubt negatively affects the result of surgery. Suggested techniques of osteal transplantation from parietal region [1], complex compound revascularizedilioinguinal, fibular, and costal flaps [2] are highly traumatic and time-consuming. They also include using miniplates as fixing constructions with titanium screws with their own defects; they do not rule out the possibility of complications connected with graft resorption and microvascular stages. Besides, inconformity of these osteal implants with the configuration of replaceable defects decreases cosmetic efficacy.

Practicable opportunities of endoprosthesis replacement of zygomatic bone and arch appeared with introduction into clinical practice of superelastic implants with permeable porosity from nickelid titanium whose configuration, form and size are in accordance with a specific clinical case [4, 9]. With this purpose in mind P.G. Sysolyatin et al. (1995) and V.A. Novikov (1999) for the replacement of absent parts of the maxilla including orbital bottom, zygomatic bone and arch, successfully used thin-profile lamellar constructions 0.5-1 mm thin obtained with electroerosion cutting of porous permeable nickelid titanium with pore size of 100-300 micron and porosity factor of 40-80% [6, 8]. The implants under discussion, thanks to shape memory qualities under changes of temperature, superelasticity at body temperature, corrosion stability under conditions of long-lasting alternating strain, hysteresis behavior under conditions of strain changes and deformity (functional load and unloading), after their insertion into the defects provide intergrowth of connective tissues from recipient areas with formation in their pores of organotypic tissue structures and developing safe fixation with body tissues [3]. Presaturation of these implants with antibiotic solution, at the expense of wettability, prevents operative wound abscess [4].

The purpose of the work consisted in enhancing the efficacy of total replacement of zygomatic bone and arch with the development of a new medical technique with use of materials with shape memory.

2 Experimental

The scientists of the Research Institute of medical materials and implants with shape memory (Tomsk, Russia) have worked out an endoprosthesis of zygomatic bone and arch which has right and left variants. It is made of porous and non-porous materials based on nickelid titanium consisting of a superelastic perforated plate with bilaterally fixed, analogous in form and size permeable porous parts. Along the front and back edges, the implant has apertures for fixation to the osteal part of the facial skull. The size and configuration of an endoprosthesis is determined individually on the basis of X-ray examinations (spiral CT – layer-by-layer and three-dimensional images) and lithographic model of patient's skull. To

improve interaction of the implant with recipient tissues and restoration of facial contours, especially in people with lack of soft tissues in the zygomatic and parotid-masticatory areas, the part of the implant between apertures was covered with superelastic netlike thin-profile nickelid titanium made of thread 40-60 micron thick [7], by layer-by-layer winding in two-three layers depending on the aim of the surgery (Fig.1).

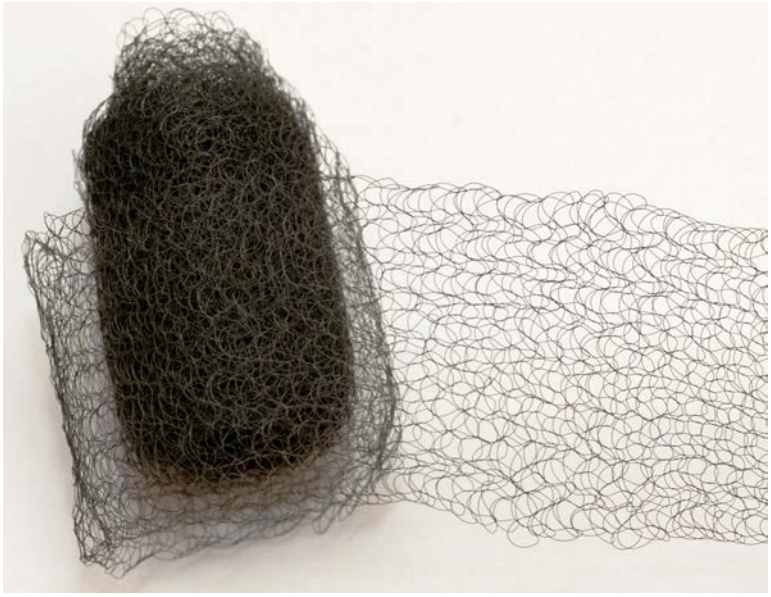


Fig. 1. Knitted TiNi-based mesh

Operative technique. One dissects the skin and subcutaneous tissue beginning in the temporal region in front of the auricle above the tragus. Then the incision is continued around the earlobe to the upper part behind the maxilla up to the projection of the mastoid bone. Further, it goes down along the sternocleidomastoid muscle round the mandibular angle in the submandibular region to the projection of the anterior edge of the masticatory muscle [5]. The cellulo-cutaneous flap is separated forward and upwards along the facial fascia to the lateral border of the suborbital region, projection of the inferior external orbital edge and infratemporal crest of the main bone. One dissects the soft tissues longitudinally taking into account the localization of the zygomatic branch of the facial nerve in the projection of the base of the zygomatic process of the maxilla and that of the zygomatic process of temporal bone; the latter are skeletonized. Between these anatomical formations along the inner surface of the muscular layer, one makes a tunnel where the endoprosthesis is placed, its narrow part resting upon the base of the zygomatic process of temporal bone and its wide one – on the base of the zygomatic process of the maxilla. The implant is fixed to these anatomical formations with the help of fixation devices shaped like braces with thermal shape memory. The cellulo-cutaneous flap is laid in its place, the wound being sutured and drained for two-three days.

3 Results and discussion

In accordance with the developed technique, three males, aged from 28 to 54 years old, with total defects of zygomatic bone and arch were surgically treated. In all the patients, postoperative period was favorable, no significant complications were observed. Follow-up treatment findings (one-two years) showed satisfactory cosmetic and functional results. Such phenomena like cutting of the endoprosthesis through soft tissues into the oral cavity or outside, or fracture and migration of the construction were not revealed.

We give the following case as an illustration:

Patient K., aged 38, consulted a doctor for cosmetic elimination of total sinistral defect of the zygomatic bone and arch. From his past history: ten years ago he was badly injured in a car accident. During primary surgical debridement of wound the fragments of the right maxilla, left zygomatic bone and arch were removed (Fig. 2). On the basis of lithographic model of the facial skull, an endoprosthesis frame was made in accordance with anatomical characteristics of the zygomatic defect (Fig. 3). The operation was made according to the developed technique with surgical d-bridement of hypertrophically changed scar tissues of the left zygomatic region. Postoperative treatment was uneventful, healing of the wound being by primary intention. On follow-up examination in a year, there were no complaints, endoprosthesis status being satisfactory (Fig. 4).

Fig. 2. Roentgenological picture of patient's K.
facial skull before surgery

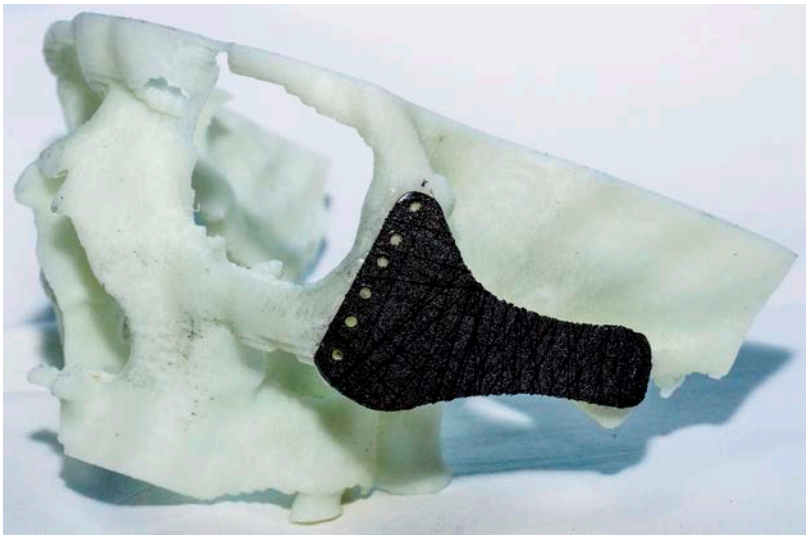
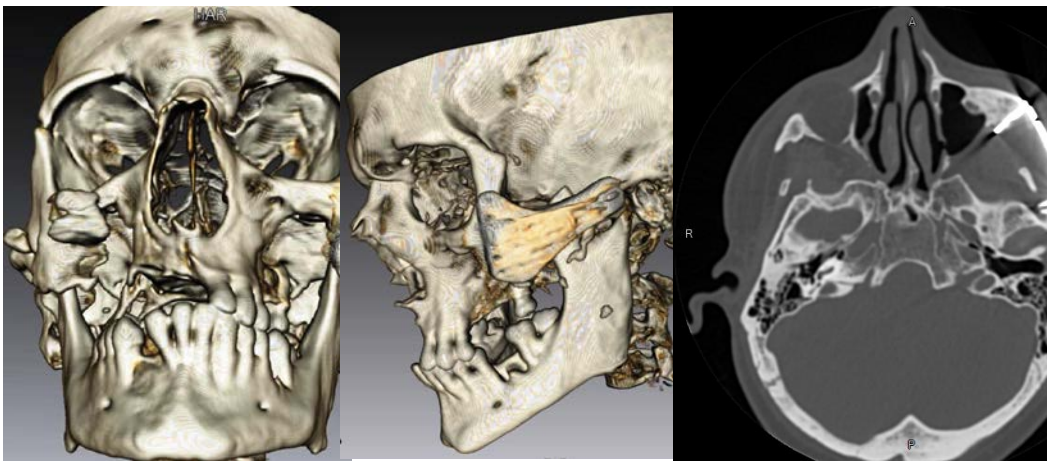


Fig. 3. Lithographic model of patient's K. facial skull before surgery and the frame of the implant



a b c

Fig. 4. Roentgenological picture of patient's K. facial skull after surgery: a – frontal projection; b – left lateral projection; c – axial projection

4 Summary

To conclude, the use of endoprostheses made of porous nickelid titanium in accordance with anatomical features of the affected organ gives an opportunity to completely restore the lost anatomical and functional properties of the facial skull. The covering of the implant frame with textile nickelid titanium, apart from improving conditions for interaction of the implant and recipient tissues, allows to the full to compensate the lack of facial soft tissue component. Fixing constructions

with shape memory effect are easy to use, are not time-consuming and they provide stable fixation of the implant with osseous structures.

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