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MANDIBULAR ENDOPROSTHESIS WITH SUPPORT ZONES AS AN ARTIFICIAL ORGAN

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Mandibular reconstruction after partial or complete resection is a prerequisite for restoring normal facial aesthetics, articulation and chewing function. We present a clinical case of lower jaw reconstruction in a female patient with acquired extensive bone defect while taking pervitin and desomorphine. Detailed descriptions of the stages of planning and performing surgery, manufacture of an individual endoprosthesis, as well as preoperative preparation of the patient are presented. Clinical and radiological data in the postoperative period were analyzed and an objective assessment of the effectiveness of the technique was given. Adequate restoration of the main functions of the lost organ was achieved thanks to the use of an individual titanium mandibular endoprosthesis with integrated dental implants and a full-arch denture.

Keywords: mandibular reconstruction, prostheses and implants, artificial organs, virtual planning, computer-assisted design.

INTRODUCTION

Mandible (M) is the only movable and most massive bone of the facial skull, which is the support and place of attachment of functionally important muscle groups. M plays one of the main roles in ensuring the functions of chewing, swallowing, articulation and, in some cases, breathing.

Extensive M defects lead to asymmetry of the lower face zone, cause functional disorders, and are also accompanied by the loss of a person's aesthetic appearance [1]. Recently, a large number of scientific works have dealt with the correspondence of the hysteresis behavior of the endoprosthesis system to the hysteresis behavior of tissues. Many works are devoted to the advantages of manufacturing individual endoprostheses [2, 3]. Nevertheless, it seems unlikely to achieve a stable functionally and aesthetically satisfactory result after arthroplasty of extensive defects of the lower jaw in the absence of dental prosthetics. Fixation of jawbone fragments with a standard titanium plate and subsequent removable prosthetics should be considered a relatively satisfactory solution. The development and implementation of more durable and physiological structures is required. Currently, the development of CAD/CAM technologies allows the manufacture of individual implants for craniomaxillofacial prosthetics.

We present a clinical observation of the stages of planning and performing surgery that describes the method of manufacturing an individual endoprosthesis of the lower jaw, as well as the features of the patient's preoperative preparation.

CLINICAL CASE

Patient A., born in 1985. In history, drug addiction based on desomorphine and pervitin. 6 years кemission. In 2004, she was operated on in the city of Ukhta, a sequestrnecrectomy was performed, and the anterior teeth were removed in the lower jaw. In 2006, a second sequestrnecrectomy was performed, removal 43, 44. In 2009, "Konmet" serial reconstructive plate was installed in Ukhta. The patient addressed the clinic of maxillofacial surgery of the Sechenov First Moscow State Medical University. In February 2012, complaints of exposure of the reconstructive plate in the oral cavity, violation of chewing and speech, deformity of the face (Fig. 1). A sanitizing operation was performed, which consisted in the removal of the incompetent metal structure and revision of the pathological focus.

At the council, it was decided to make an individual endoprosthesis with the inclusion of support zones for subsequent prosthetics in order to restore the chewing function. Preliminarily, the erupted metal structure was removed, and inflammation was relieved. In September 2012, a surgical intervention was performed in the amount of endoprosthetics of the lower jaw.

***Preoperative planning**. The patient underwent multispiral computed tomography of the skull with volumetric reconstruction of the image, on which the subtotal defect of the lower jaw is determined, as well as the defect of the left maxillary bone with complete edentulousness in the second segment. Stereolithographic models were made according to MSCT data. A team of authors, together with engineers of the Konmet company, has developed*

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an individual titanium endoprosthesis with shafts for implants [4]. The implants were fixed into the body of the endoprosthesis in the factory (Figs. 2, 3).

***Operation**. Typical submandibular incisions were made on the right and left, as well as a preauricular approach using the Bramley-Al-Kayat technique [5]. In the area of the preserved area of the lower jaw body, on the right and on the left, an osteotomy of the cortical layer was performed, a groove 2 mm wide was formed for laying the anterior part of the endoprosthesis fragment.*

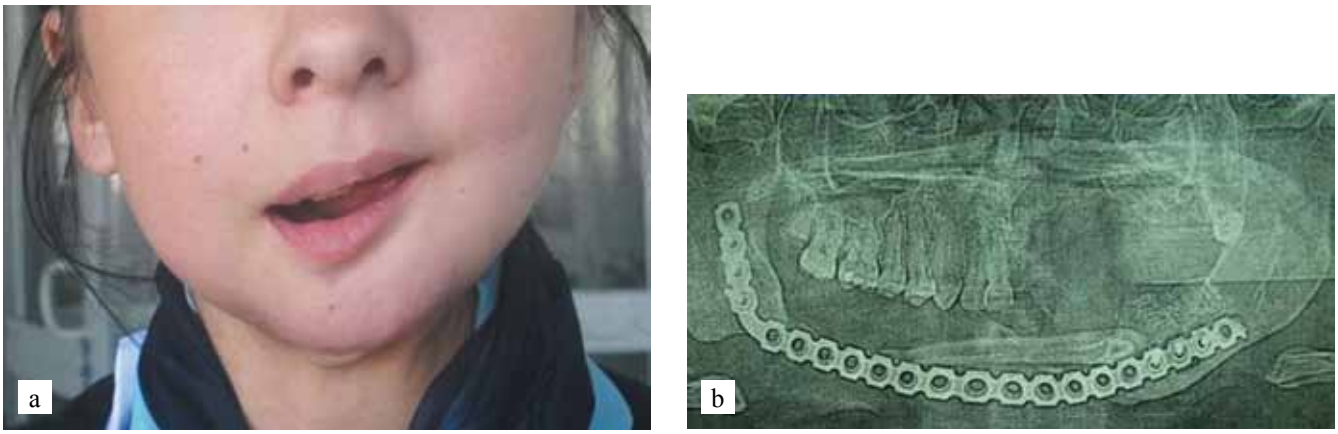

Fig. 1: a – appearance of the patient when applying to the clinic of maxillofacial surgery of the Sechenov First MSMU; b – orthopantomogram, condition after resection of the mandible and fixation the reconstructive plate of mass production

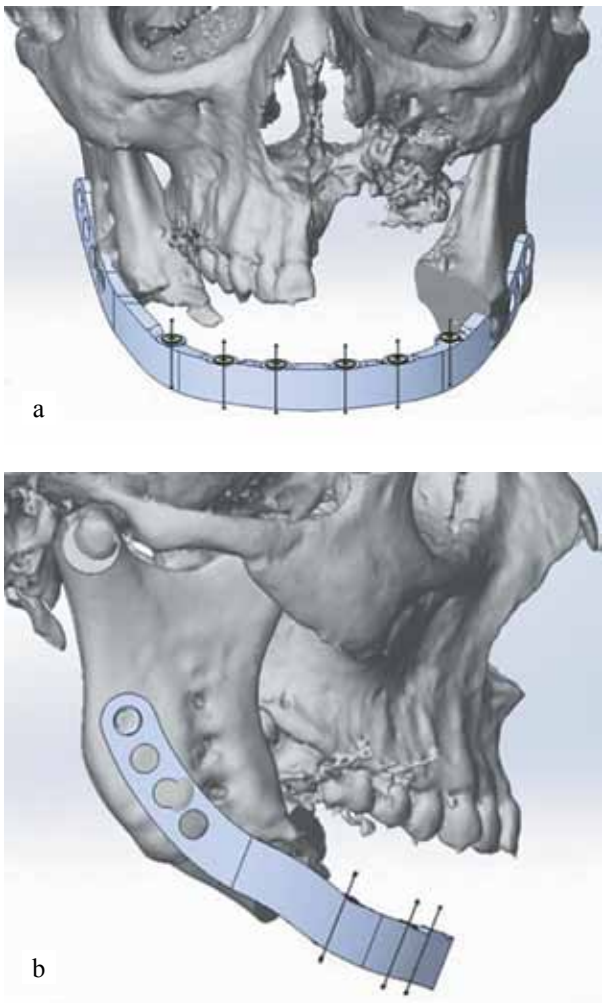

Fig. 2. Analysis of the virtual model of the visceral cranium. Modeling an individual endoprosthesis of the mandible

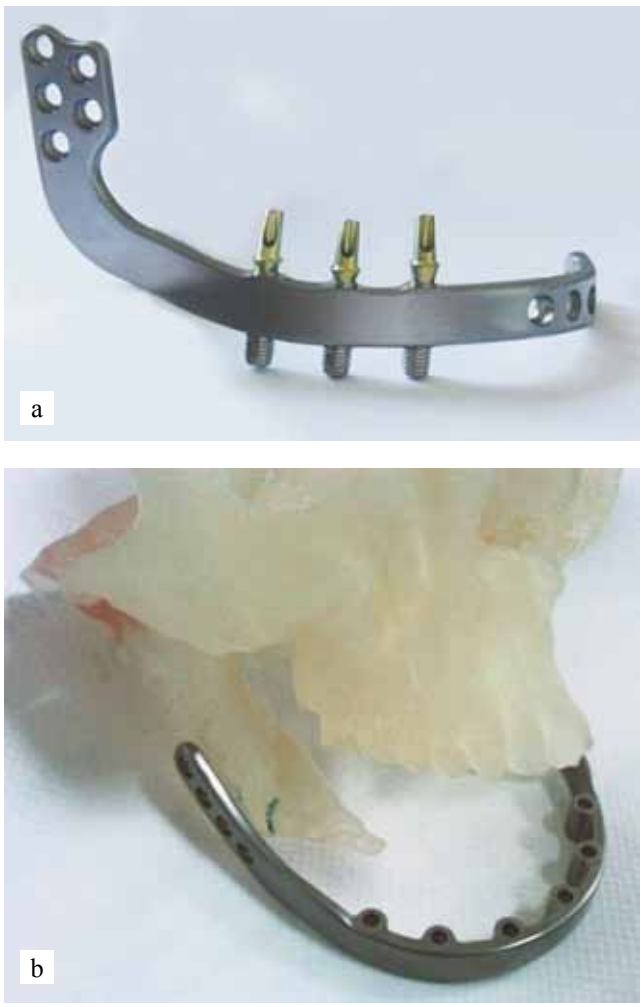

Fig. 3. Planning the stages of the operation. Fitting an individual endoprosthesis with supporting zones for dental implants on a stereo model

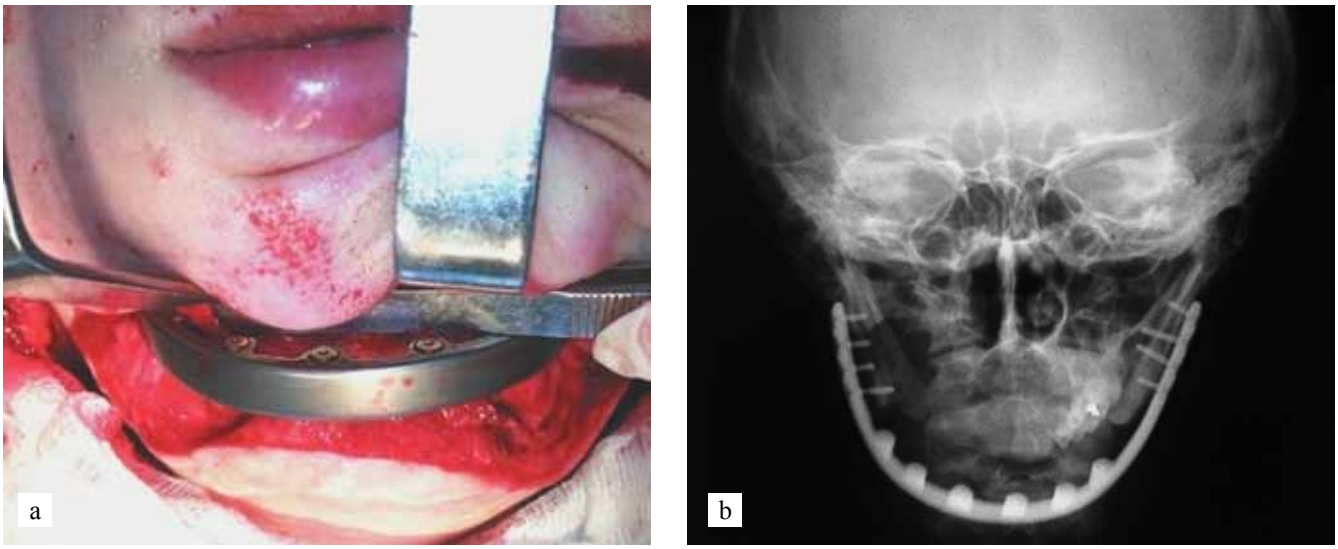

Fig. 4. Implantation and fixation of the endoprosthesis: a – stage of the surgery; b – postoperative roentgenogram

The endoprosthesis was installed and fixed with screws in the area of the corner and branch of the lower jaw on the right and left.

The wound was sutured in layers, latex drains were left for 2 days (Fig. 4). The patient underwent complex antibacterial, anti-inflammatory, symptomatic therapy.

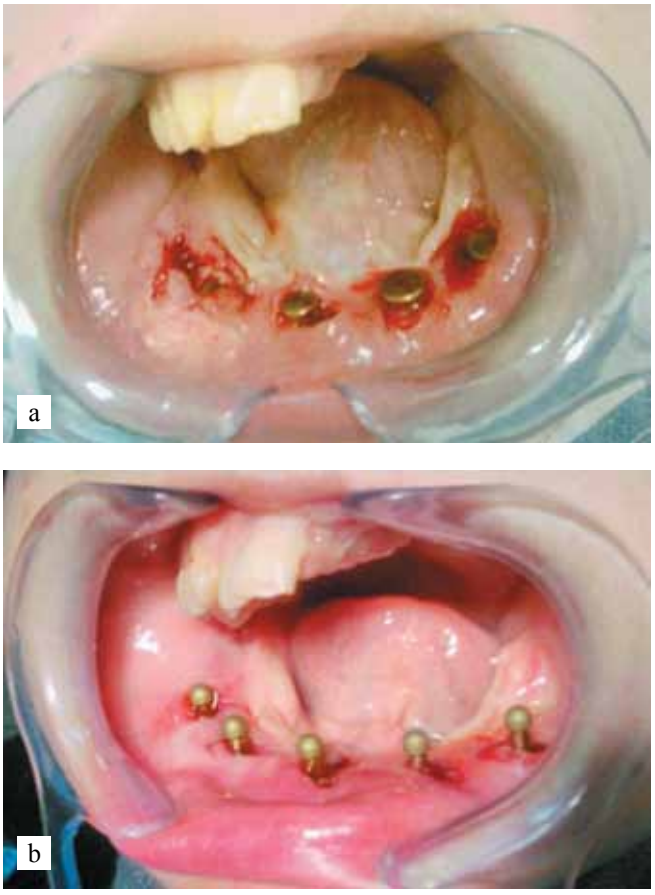

Fig. 5. The condition of the tissues in the oral cavity: a – gingival formers are installed; b – transfers are established to obtain a working impression of the mandible

The early postoperative period was uneventful. Wounds were healed by primary intention, without complications. Removal of sutures on the skin was performed on the 7th day, sutures in the oral cavity – after 14 days.

In 6 months, the gingival margin formers were installed. After 14 days, an impression was taken using transfers (Fig. 5). Prosthetics was performed with the manufacture of a conditionally removable prosthesis of a bar construction on individual abutments (Fig. 6, 7). The cosmetic and functional results were assessed as satisfactory by the specialists and the patient herself. The restoration of the shape and size of the lower jaw, the contours of the face in general, an increase in the amplitude of movements of the lower jaw were noted. A positive result persists for 6 years after the operation (Fig. 8).

The advantage of the endoprosthesis used is that after installation, it is completely covered with mucous membrane, and individual abutments are placed on a delayed basis. This fact reduces the risk of postoperative infection and increases the rate of healing.

***Recommendations**. After implantation of the endoprosthesis, the mucous membrane must be completely sutured to avoid infection. Impression taking and prosthetics should be delayed. After the end of the regeneration of the tissues surrounding the endoprosthesis, prosthetics can be performed using individual abutments. The flushing zone of the denture should be 1.8–2 mm to ensure satisfactory oral hygiene [6].*

DISCUSSION

One of the important anatomical features of the jaws is the presence of teeth that perform a number of functions, which imposes a certain specificity not only on the course of diseases of the maxillofacial region, but also on the approaches to their treatment and rehabilitation

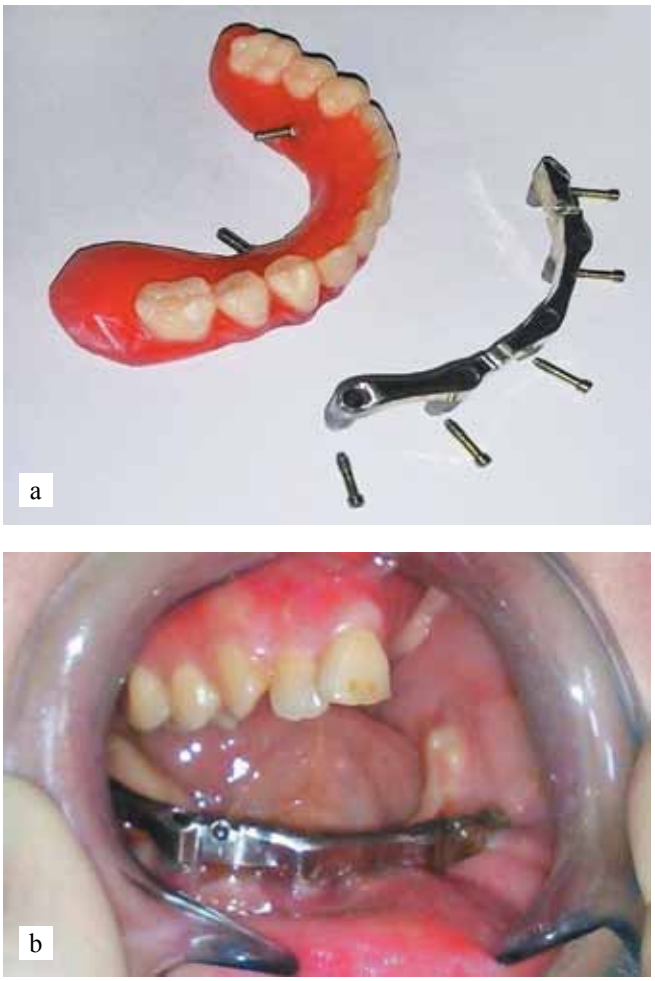

Fig. 6. Production of a conditionally removable denture on a beam construction

[7, 8]. Loss of a fragment of the lower jaw with the loss of the chewing function on the affected side leads to uneven work of the group of masticatory muscles with the development of secondary asymmetry of the face. In addition, additional trauma to the mucous membrane in the absence of dental prosthetics leads to the eruption of the endoprosthesis. In addition, the absence of antagonist teeth in the teeth of the opposite segment leads to a decrease in their functional load, the development of the Popov – Godon phenomenon [9], periodontal diseases and early loss of intact teeth. The absence of teeth leads to pathology of the temporomandibular joint (TMJ), which is one of the important organs involved in postural control of the human body [10].

D.A. Nikitin et al. [11] developed a clinical classification of defects in the bone structures of the lower jaw, considering the possibility of using the method of dental implantation in reconstructive operations. The authors identified three groups of patients. According to this classification, extensive defects of the lower jaw with disruption of its continuity in the frontal and lateral parts were attributed to the 3rd class.

Fig. 7. Appearance of the patient after conditionally removable prosthetics

Currently, the most common reconstructive operations in patients with extensive acquired defects of the maxillofacial area (MFA) are performed using allografts, revascularized and nonvascularized autografts, endoprostheses. Based on the analysis of the properties of the above groups of grafts (Table), there is reason to

Table

Pros and cons of various reconstructive materials

Reconstructive material	Advantages	Disadvantages
Allograft	Does not require the creation of an additional operating field; there is a possibility of replacing combined defects of the face and jaws; the possibility of transplantation in patients with cancer in remission (more than five years) and in HIV-positive patients [12]	The need to create a bone bank [13], technological complexity, differences in the size and geometry of the donor site and the defect [14], it is impossible to exclude the possibility of infection of the recipient; ethics committee approval required
Nonvascularized autograft	Less technically complex and costly operation compared to the use of a vascularized graft, there are more sites to choose; reducing the risk of graft rejection	Donor site trauma; limited available volume for sampling [15]; resorption [16, 17]; it is not always possible to make up for an extended defect [14]; risk of infection [18]
Revascularized autograft	Possibility of replacing extended jaw defects (up to 8 cm); used after radiation therapy and in soft tissues with cicatricial changes; the possibility of implantation (there are both positive and negative results) [18, 19]; preventing the risk of graft rejection	Injury of the donor site, expensive equipment and high qualification of the surgeon are required, it is not always possible to fill the defect; long operation time; the need for two specialized surgical teams; morbidity; longer hospital stay [20–23]
Endoprosthesis	Does not require the creation of an additional operating field; the ability to manufacture an individual endoprosthesis with pre-calculated optimal geometric parameters, which can significantly reduce the operating time; the possibility of prosthetics when using an endoprosthesis with support zones	Fracture of the fixing part of the endoprosthesis, intrusion of its head into the cavity of the middle cranial fossa during arthroplasty; eruption [24]; risk of infection or infection; the thickness of the endoprosthesis, which does not provide a sufficient volume of reconstruction [14]; material fatigue, which imposes restrictions on the duration of operation

Fig. 8. Oral cavity examining (September 2019)

believe that endoprosthetics is one of the most promising techniques.

Most authors positively assess the experience of using endoprostheses of the lower jaw, emphasizing its prospects [7, 24]. In cases of removal of the TMJ with the M branch as a single block, one should not forget about the preservation of the above function in the intact joint. It should be noted that the use of the temporal bone glenoid fossa prosthesis prevents the recurrence of ankylosis and the penetration of the articular head of the endoprosthesis into the cavity of the middle cranial fossa [25].

Historically, for M and temporomandibular joint (TMJ) arthroplasty, alloys resistant to corrosion in body fluids have been used: stainless steel, an alloy of cobalt (vitalium), chromium, molybdenum, and tantalum [26]. The most popular were endoprostheses of the Vitalium M branch, proposed by B.S. Freeman (1948) [27]. In subsequent years, materials from titanium and its alloys were actively introduced into medical practice. In particular, R.W. Christensen (2004) developed numerous variants of titanium prostheses, described the methods of surgical interventions for prosthetics of the glenoid cavity and the M branch [2].

Positive properties of titanium and its alloys include high biocompatibility; bioinertness in body tissues; corrosion resistance due to the formation of an oxide film that is stable in the environment of the body; modulus of elasticity close to the modulus of elasticity of the bone; non-magnetic; low thermal conductivity; low coefficient of linear expansion; no clinically significant toxicity [28]. In addition, experimental experimental studies on animals have shown that titanium structures are more resistant to fatigue loading compared to other materials [7].

Nevertheless, the development and introduction into clinical practice of more advanced material [28, 29] does not exclude the development of both early and late complications, which can be associated, among other reasons, with the insufficient physiological nature of the replacement construct.

According to the specialized literature, the most optimal current method of rehabilitation in patients with partial and complete edentulousness in patients is dental implantation [30]. Nevertheless, this method of restoration of the dentition is, for obvious reasons, practically impracticable during a standard metal endoprosthesis [31]. Based on the anatomical, functional and aesthetic significance of M, we can say that the operation to implant the proposed metal structure is equivalent to the creation of an artificial organ, which is especially important for maintaining an acceptable standard of living for the patient.

CONCLUSION

Thus, due to the proposed technique, it is possible to solve the main tasks of reconstructive surgery in patients with extensive defects of the lower jaw: to restore functions, as well as to recreate the facial aesthetics as closely as possible, which, in turn, has a significant effect on the patient's quality of life. This clinical case clearly demonstrates that the use of an individual endoprosthesis of the lower jaw with integrated dental implants, followed by the manufacture of a conditionally removable orthopedic structure, allows to obtain a predictable stable result and is quite promising in terms of patient rehabilitation.

The authors declare no conflict of interest.

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