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ADVANCEMENT OF SURGICAL TREATMENT OF ORBITAL FLOOR FRACTURE

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ABSTRACT

Introduction. The article analyzes the literature data on diagnosis, planning and surgical treatment of patients with orbital floor fractures. Until the 70s of the twentieth century, purulent-inflammatory diseases of the face and neck were the predominant pathology, followed by a gradual increase in the number of patients with traumatic injuries. Modern statistics also indicates an increase in the number of patients with fractures of the facial skeleton as one of the most common injuries of the middle zone of the face, in frequency second only to damage to the nasal bones. Despite a significant number of works, the literature data on the choice of diagnostic, planning and surgical treatment are rather fragmentary and not systematized, which allows to orient the activity of the maxillofacial surgeon and scientific research on the development and improvement of diagnostic methods, planning and surgical treatment of orbital floor fractures.

Key words: orbit, zygomatic-orbital complex, 3D reconstruction, 3D modeling, 3D computed tomography.

Introduction. In modern conditions of development of society, improving the quality of medical care is of crucial social importance. Scientific and technological progress and the totality of modern social relations present ever higher professional, moral, ethical and legal requirements for healthcare professionals [1].

Over the past decades, there has been a qualitative leap in the incidence of maxillofacial organs, both traumatic and inflammatory. One of the directions for the development of measures to improve medical care for patients with urgent pathology was the analysis of injury indicators. It is noteworthy that until the 70s of the twentieth century, purulent-inflammatory diseases of the face and neck were the predominant pathology, followed by a gradual increase in the number of patients with traumatic injuries. Over the years, fractures of the lower and upper jaw have been leading in the structure of traumatic injuries [10.36].

Modern statistics indicate an increase in the number of patients with fractures of the facial skeleton. Orbital fractures - one of the most common injuries of the middle zone of the face, in frequency second only to damage to the nasal bones. According to P. Siritongtaworn, eye socket fractures account for 40% of all facial skeleton fractures. Isolated eye socket fractures occur in approximately 35–40% of cases. Fractures of the cheek-eye complex prevail, which account for 14.5 to 24% of facial skull injuries [15,26].

The most severe eye injuries occur during fractures of the outer wall of the orbit, its apex, and face bones according to Le Fort III type. Isolated fractures of the lower wall of the orbit are associated with less severe damage to the eye. In half of the cases, orbital fractures are associated with traumatic brain injury (TBI), and the likelihood of its occurrence increases significantly when two or more orbital walls are damaged [33].

In recent years, there has been an increase in the number of patients with traumatic injuries of the maxillofacial area both in Russia and in Europe and the USA. The increase in the frequency of injuries of the cheek-eye complex with damage to the lower wall of the orbit is associated with an increase in the number of vehicles, and accordingly, an increase in injuries resulting from an accident. Due to the accelerated pace of life and increased stressful situations, the growth of household injuries is increasing. Every year, the number of sports injuries and various injuries resulting from military operations is increasing. A significant problem is the worsening of injuries [14].

With external influences on the orbit, also mechanical injuries occur, accompanied by damage to soft tissues and bone structures. During orbital contusion, isolated fractures of the lower orbit wall, which account for 35–40%, are most often encountered [8]. Contusion injury of the orbit leads to a dysfunction of binocular vision. Deformation of the lower contour of the bone skeleton of the orbit during injury, as well as the length of the fracture in the anteroposterior direction (fracture depth) may not be noticed during the initial examination due to severe edema and hematoma of the eyelids. Small changes in the bone orbit, extraocular muscles, orbital fiber become the cause of diplopia, decreased visual acuity, cosmetic defect, which creates problems in the patient's social and professional adaptation [4]. In this regard, it is relevant to improve the quality of diagnosis in case of contusion of the orbit with an isolated fracture of the lower wall. For the first time, a fracture of the lower wall of the orbit was described in 1844 by MacKenzie (Paris). The term blow-out fractures appeared in 1957, when Smith and Regan observed a case of a fracture of the lower wall of the orbit with interposition of the lower rectus extraocular muscle and restriction of the movements of the eyeball [35].

It is generally accepted that fractures of the lower wall of the orbit of the blow-out type occur due to the impact of a blunt object on the anterior regions of the orbit. Often a traumatic item is a fist, elbow, ball, etc. The force action extends from the edge of the orbit and the eyeball to the bottom of the orbit, causing damage to it in the thinnest section, most often in the medial zone near the infraorbital canal.

An increase in pressure inside the orbit leads to a fracture of the bone structure and prolapse of soft tissues into the lumen of the maxillary sinus. Interposition of the lower straight or lower oblique extraocular muscle in the fracture line is possible. This circumstance or the presence of edema of the above structures causes a restriction of the movements of the eyeball, leading to the occurrence of diplopia. Isolated blow-out fractures in the area of the medial wall of the orbit are much less common, mainly in the context of trauma to the nasorbital-ethmoid complex [17]. Fractures of the lower wall of the orbit, the cheek-eye complex, which need treatment using modern equipment, take 2nd place after fractures of the lower jaw and 1st place among injuries of the middle zone of the face [18]. Despite the successes achieved in the prevention and treatment of injuries of the organ of vision, blunt injuries of the orbit with damage to its walls remain an urgent problem of modern maxillofacial surgery and ophthalmology.

Since 1915, many researchers have tried to create a three-dimensional model of a face standing in an anatomically correct position. It was a complex and laborious process that turned out to be inapplicable for use. In the 80s of the last century, a 3D image of the maxillofacial region was developed. This technology included laser and computer-topographic scanning, stereolithography, moire topography, stereophotogrammetry, and other methods [2].

The creation of computer tomographs, the development of visualization techniques for various human organs and systems have expanded the understanding of clinicians about their intravital topographic anatomy. Introduction to clinical practice of computer diagnostics significantly improved diagnostics, made it possible to conduct studies in the grave condition of victims in the acute period of trauma, to determine the localization and prevalence of bone tissue destruction, to reveal the topographic relationship of the orbital fracture with the sinuses and the cranial cavity [5,19,29].

Improving diagnostic methods in maxillofacial surgery requires the introduction of more informative and ergonomic techniques, which was made possible thanks to computer technology. A transition is needed from two-dimensional analysis — telerentgenograms of the head in lateral and direct projections, symmetroscopy, symmetrography, photosymmetroscopy and its modification of two-dimensional digitizers — to three-dimensional, in which the most reliable estimation of parameters is possible [2, 11].

Diagnosis and treatment methods in maxillofacial surgery. One of the perfect diagnostic and treatment planning methods is 3D reconstruction, with which you can accurately determine the nature and location of the injury [1,20]. The construction of three-dimensional graphical models is based on the acquisition of X-ray computed tomograms at minimal time intervals, allowing to create texture segmentation and three-dimensional reconstruction of organs. This is diagnostically significant due to the visualization of the human body in various planes with the possibility of examining the internal surfaces of both the soft tissue contour and bone structures [7,28].

Based on the foregoing, it can be concluded that X-ray studies with three-dimensional reconstruction of damage to the walls of the orbit make it possible to establish the size and configuration of the bone defect in both fresh and old fractures, especially deformations and defects of the lower wall of the orbit [7,10].

Correction of post-traumatic deformations of the middle zone of the face is a difficult task of modern medicine [15]. The most anatomically and functionally complex part of the middle zone of the face is the orbit and its contents. In case of violation of the integrity of the bone walls, the volume of the orbit changes, which leads to a change in the position of the eyeball (hypophthalmos, exophthalmos, enophthalmos), displacement of fiber from the orbit into the paranasal sinuses, impaired eye mobility, and with preserved visual function, to diplopia [9].

The main place in the surgical treatment of patients with defects and deformations of the middle zone of the face is occupied by reconstructive (osteoplastic) operations. Reconstructive measures include osteotomy, reposition and fixation of bone fragments in the correct anatomical position. It is known that reposition of bone fragments after the 14th day after injury is difficult due to the formation of fibrous adhesions and lysis of the edges of bone defects, as a result of which it is not possible to achieve a clear anatomical comparison of fragments, and therefore, an important stage in the reconstruction of deformations is the replacement bone defects with various implants [11,16].

One of the modern methods of planning surgical treatment of patients with fractures of the lower wall of the orbit is a 3D reconstruction and a virtual computer model, with which you can accurately determine the nature and location of the injury. 3D planning allows you to plan and determine the scope of the operation, select the implant, determine its size and type, as well as the method of fixation. Thanks to the 3D model, it is possible to determine the indication and contraindication for surgery, to select less traumatic access to the damaged area, in addition, this method also avoids postoperative complications, such as enophthalmos, diplopia, exophthalmos, etc. [20].

The method of computer three-dimensional modeling of orbital walls taking into account reference points, deformations and defects, as well as the necessary transplants is based on the use of computer tomograms as a background for modeling nodes of a three-dimensional lattice. This method of graft modeling facilitates the reconstruction of a deformed orbit, increases the accuracy of positioning and, in general, the efficiency of the operation [17].

Based on this method, individual stereolithographic models are made for patients, which, according to the architectonics of the middle zone of the face and the presence of a defect, make an implant that completely closes the defect of the lower wall of the orbit.

Variety of materials applied in maxillofacial surgery. As implants and grafts of the lower wall of the orbit, autobone is used from the anterior wall of the maxillary sinus, rib, parietal bone, branches of the lower jaw, titanium implants without coating and coated with high density polyethylene, polytetrafluoroethylene, silicone.

The advantage of autografts is the stimulation of osteoinduction, osteoconduction, osteogenesis and revascularization. Autologous tissue compares favorably with biocompatibility, a minimal risk of infection, migration, and rejection. The disadvantages of autotransplantation include an increase in the time of surgery, additional surgical trauma, complications associated with the collection of material, lysis of a third of the transplanted autotissue with the development of enophthalmus in the long term, and the difficulty of forming a small graft [22,32,37].

If it is necessary to transplant small plastic implants, some authors recommend replanting the costal cartilage [3.34], nasal septum cartilage [30.37], and ear cartilage [22].

Some experts justify the use of allochondral or allograft grafts with the possibility of creating a graft of the desired size, its modeling and resistance to infection, and the absence of an additional surgical field for receiving the graft [21]. Decalcified bone stimulates chemotaxis and the transformation of mesenchymal cells into chondroblasts in the fracture zone, followed by ossification. A serious drawback of cartilage transplants devoid of epichondria is their gradual (within 1-1.5 years) resorption, which is confirmed by computed tomography [6]. Silicone implants are widely used in world practice [25]. When using them, complications such as infection, an orbital abscess, an implant displacement in the maxillary sinus with a fistula in the lower conjunctival arch due to the lack of isolation of the sinus from the orbit cavity, and persistent diplopia are described [30]. Another development designed to close defects was titanium-reinforced polyethylene implants [27]. The disadvantages of polyethylene include radio transparency, which is why the material begins to be visualized on CT grams only after the completion of vascularization processes [37]. It turned out that placing it directly under the skin (without periosteal or fascial coating) is fraught with early and especially late outcrops, the frequency of which exceeds 10% [33]. In addition, due to excessive stiffness, he poorly follows the contours of the face [24]. The successful use of a composite hydrogel implant is described, which is an elastic polymer plate into which a titanium miniplate is polymerized [26]. Among the possible complications, inflammatory processes in the maxillary sinus are mentioned, which occur in 7.4% of cases.

Some authors use Vicryl (polyglactin) for reconstruction of the bottom of the orbit, correction of anophthalmos and enophthalmos [28]. Its advantages include the possibility of processing to give the necessary shape, the absence of irritation of surrounding tissues, resorption.

Due to the inherent elasticity of vicryl, it is impossible to compress the optic nerve, lacrimal sac or oculomotor muscles. It is well tolerated by the tissues of the orbit, bone, and the mucous membrane of the paranasal sinuses, and does not interfere with osteogenesis [27]. However, in 14% of cases it causes an inflammatory reaction of tissues of the lower eyelid, fraught with cicatricial deformity [32]. In addition, a week after implantation, polyglactin begins to lose its original strength, a month later there are traces of the plate, after 4 months its complete resorption is noted, which does not allow it to be used to close significant defects of the lower wall and orbital contour. As shown by long-term studies of Russian and foreign scientists, alloys based on titanium nickelide are the most prominent representatives of the class of alloys with a shape memory effect [13,12,31]. Titanium is biologically inert, corrosion resistant, non-toxic, has high mechanical strength, ductility, non-magnetic, low specific gravity. The biocompatibility of titanium is explained by the proximity of its serial number (22) to calcium (20), the main mineral component of the body [25]. High tensile strength and low modulus of elasticity allow you to create a contour of the bones of the face [23]. It has been established that superplastic medical materials based on titanium nickelide surpass all existing metal materials in terms of biochemical and biomechanical compatibility. The use of titanium nickelide implants has improved the surgical treatment of patients with fractures of the lower wall of the orbit and post-traumatic deformations of the middle zone of the face.

The use of porous titanium nickelide implants has reduced the time of surgery, eliminated the risk of infection, the formation of a fibrous capsule on the periphery of the implant, which is essential in the prevention of cicatricial changes and enophthalmos. Due to these properties of titanium nickelide, the possibility of intraoperative implant modeling in accordance with the natural contours of the orbit helps to reduce the time of surgery and the rehabilitation period [13,12].

Conclusion. An analysis of the literature indicates a wide range of materials of natural and artificial origin used in reconstructive plastic surgery of the periorbital region. The success of the use of biomaterials is largely ensured by the degree of their biocompatibility and an individual approach to determining indications for their use. It was noted that surgeons working in the middle zone of the face often use materials of a non-biological nature due to their availability and less operational trauma. However, this increases the risk of exposure, displacement of implants, the formation of epithelial pseudocysts around them, infection, especially when such material comes into contact with the mucosa of the maxillary sinus. Analysis of literature data indicates the need to develop new methods for treating patients with damage to the walls of the orbits, aimed at reducing the morbidity of surgical intervention and the number of complications.

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