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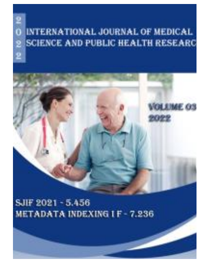

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Research Article

CLINICAL APPLICATION OF 3D PRE-BENT TITANIUM IMPLANTS FOR FRACTURES OF INFERIOR WALL OF THE ORBIT

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Shokhrukh Yusupov
Phd, Senior Lecturer, Tashkent Medical Academy, Uzbekistan

ABSTRACT

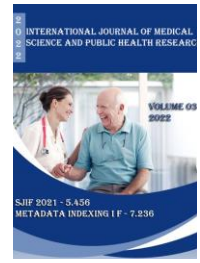
Traumatic injuries of the bones of the middle zone of the facial skeleton represent one of the most difficult problems of maxillofacial surgery. The percentage of traumatic injuries of the maxillofacial region worldwide remains at a constantly high level with no tendency to decrease. According to different authors from 6 to 23% in the structure of trauma by localization of injuries belongs to the middle zone of the face (Levchenko O.V., A.Z. Shalumov, 2011; Brasileiro B.F., Passeri L.A., 2006; O. Obuekwe, F. Owotade, O. Osaiyuwu, 2005). The unique anatomy of the orbit and the resulting surgical approaches make the process of fitting and aligning implants difficult, time consuming and operator dependent. It is now possible to make relatively in-expensive anatomical models on the basis of computed tomography images, using rapid prototyping. Such models can be as templates to form titanium implants, which are then used in the reconstruction of defects of the inferior wall of orbit. Material and methods: 32 patients with facial trauma were included in this study. First, 3D virtual models and then physical models were created. These were used as templates to shape the titanium mesh and then intraoperatively as guides to aid correct implant placement in the orbit. Results: Significant improvement resulted in thirty two cases and total recovery 32 cases. Conclusion: It is financially viable to build anatomical models, on the basis of CT studies, that can be used in the repair of orbital floor fractures.

KEYWORDS

Orbital fractures, orbital implants, computer models, anatomical models, computed tomography.

INTRODUCTION

Orbital fractures are one of the most common injuries to the midface, second only to injuries to the nasal bones. According to P. Siritongtaworn et al (2001), orbital fractures account for 40% of all facial skeleton



fractures. And also the number of orbital injuries, accompanied by fractures of its walls, is steadily growing (Nerobeev A.I. et al., 2012, Grusha Ya.O., 2009, Kummoona 2010, Yilmaz et al., 2007). However, a number of authors claim that trauma to the orbit involving the eyeball and its auxiliary organs among all injuries of the facial skeleton ranges from 36 to 64%. The level of binocular vision impairment is especially high in fractures of the inferior wall of the orbit, and this is the most common type among all orbital fractures.

Currently, there are a number of controversial issues related to the lack of a unified approach to the treatment of traumatic fractures of the orbital walls and to the use of one or another method of orbital plastic surgery. There are many different modern auto- and allogeneic transplants and implants for orbital reconstruction: autografts (Karayan A.S., Kudinova E.S., 2002), titanium plates and meshes (Sandoval H.M., Gunko V.I. , 2011), synthetic implants made of porous polytetrafluoroethylene (Meskhia Sh.M., 2009), porous titanium nickelide (Medvedev Yu.A., Gunter V.E., Shamanaeva L.S., 2012), silicone (Kalashnikova E.N. ., 2008), polypropylene.

Variants of orbital fractures vary greatly in shape and localization. Since the bony orbit is a formation of irregular pyramidal shape with significant individual deviations, it is very difficult to obtain any landmarks by which to reconstruct the orbital walls.

3D technologies are the advanced technologies filling the modern human life. 3D technologies are based on 3D modeling. Today it is difficult to imagine the work of a designer, designer, animator without the use of 3D models built with the help of a computer. Even more widespread 3D modeling has received in connection with the spread of 3D printers. Now 3D models are used in all branches of science, technology, medicine, commercial and managerial activities

Planning of reconstructive surgical intervention in patients with defects and deformities of the facial skeleton using computer modeling helps to reduce the time of surgical intervention and increases the accuracy of planning and implementation of surgical treatment.

Thus, traumatic injuries of the middle zone of the face represent one of the most difficult problems of maxillofacial surgery. The number of patients with this pathology remains constantly high, which is due to the increase in the number of household trauma, road traffic accidents.

Purpose of the work.

The aim of this study was to present a method of repairing orbital floor fractures using pre-shaped titanium mesh implants that were formed on anatomical models of the orbit.

METHOD

The study was based on the examination data of 32 patients with fracture of the inferior wall of orbit treated in the Department of Plastic Surgery of the TMA Multidisciplinary Clinic between 2022 and 2023.

All patients (n=117; 100%) underwent MSCT on a GE Light Speed 64 device during hospitalization. Tomography of the facial skeleton was performed with the following parameters: slice thickness - 0.6 mm, slice collimation - 64*0.6, mAs/slice - 200, voltage - 120 kV, incriment - 0.6, pitch - 0.5, reconstruction resolution - high, radiation exposure - 0.4 - 0.8 mSv. The patient was placed on the tomograph table deck in the supine position. The patient's head was previously freed from all removable metal elements and laid flat on the headrest. The patient's gaze was asked to be fixed centrally. Laser markers were used to precisely define the scanning area. A topogram was performed to mark the study area. Tomography was started from the top of the skull to the lower border of the mandibular body (or from the frontal region to the alveolar process of the maxilla).

MSCT data in the axial, sagital, and coronal planes were supplemented with multispiral reconstruction in the coronal and sagittal planes with 3D reconstruction (Fig. 1).

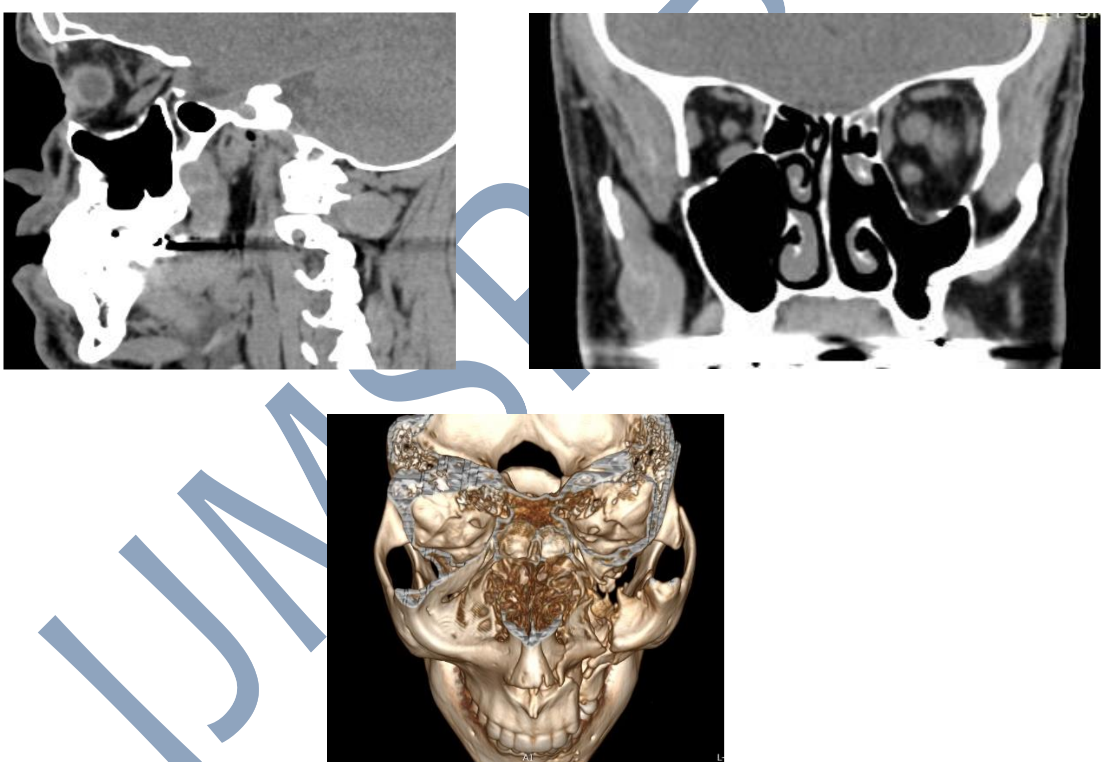
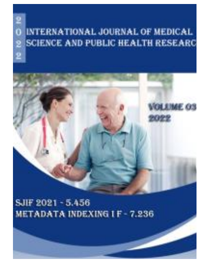


Fig. 1. MSCT with 3D reconstruction of the patient before surgery

Algorithm of implant modeling using a 3D surgical template for the elimination of defects of the inferior wall of the orbit. A computer 3D model of the orbit with a stereolithographic intraoperative template printed on a 3D printer was made for all patients in the preoperative period (Fig. 2). After surgery, the patient underwent daily dressing, clinical examination of the patient (position of the eyeballs, their mobility, change



of sensitivity in the zone of innervation of the inferior orbital nerve, presence of diplopia, and change of the eyeball position). Then we performed manual examination of the periocular region, which included palpation of the lower orbital margin of the orbit.

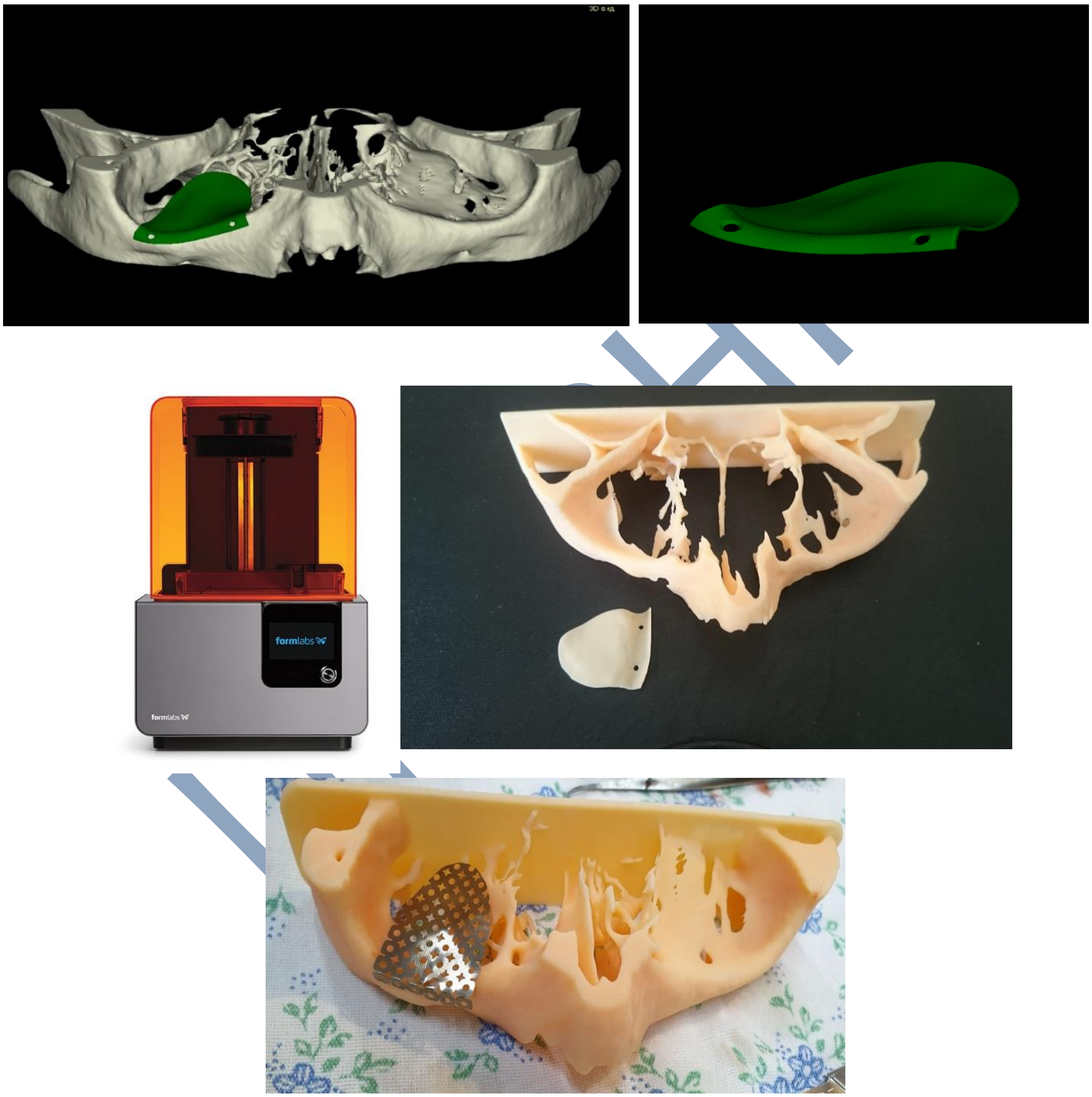


Рис. 2. Method of repairing defects of the lower wall of the eye socket using a preoperative 3D surgical template

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RESULTS

All patients underwent surgical intervention under general anesthesia and included the stage of osteosynthesis of the lower edge of the eye socket and endoprosthesis of the orbital walls.

All patients (32; 100%) had a computer 3D model of the orbit with a stereolithographic intraoperative template printed on a 3D printer in the preoperative period.

Surgical treatment of isolated injuries of the lower wall of the orbit in the main group (32% 100) was performed according to the technique developed by us with observance of a number of peculiarities depending on the severity and localization of injuries, as well as the terms of surgical intervention. The most important stage of the operation was careful revision of the orbital fractures, release of the pinched oculomotor muscles, elimination of the orbital fiber prolapse, and also the most important is the plasty of the bone defect of the lower wall of the orbit, based on the stereolithographic intraoperative template, with the help of which the exact size, shape of the implant and the place of its fixation are determined, and the implant itself is a porous titanium membrane. In the postoperative period, all patients were treated with standard anti-inflammatory therapy, and rehabilitation was performed together with an ophthalmologist to restore eye function.


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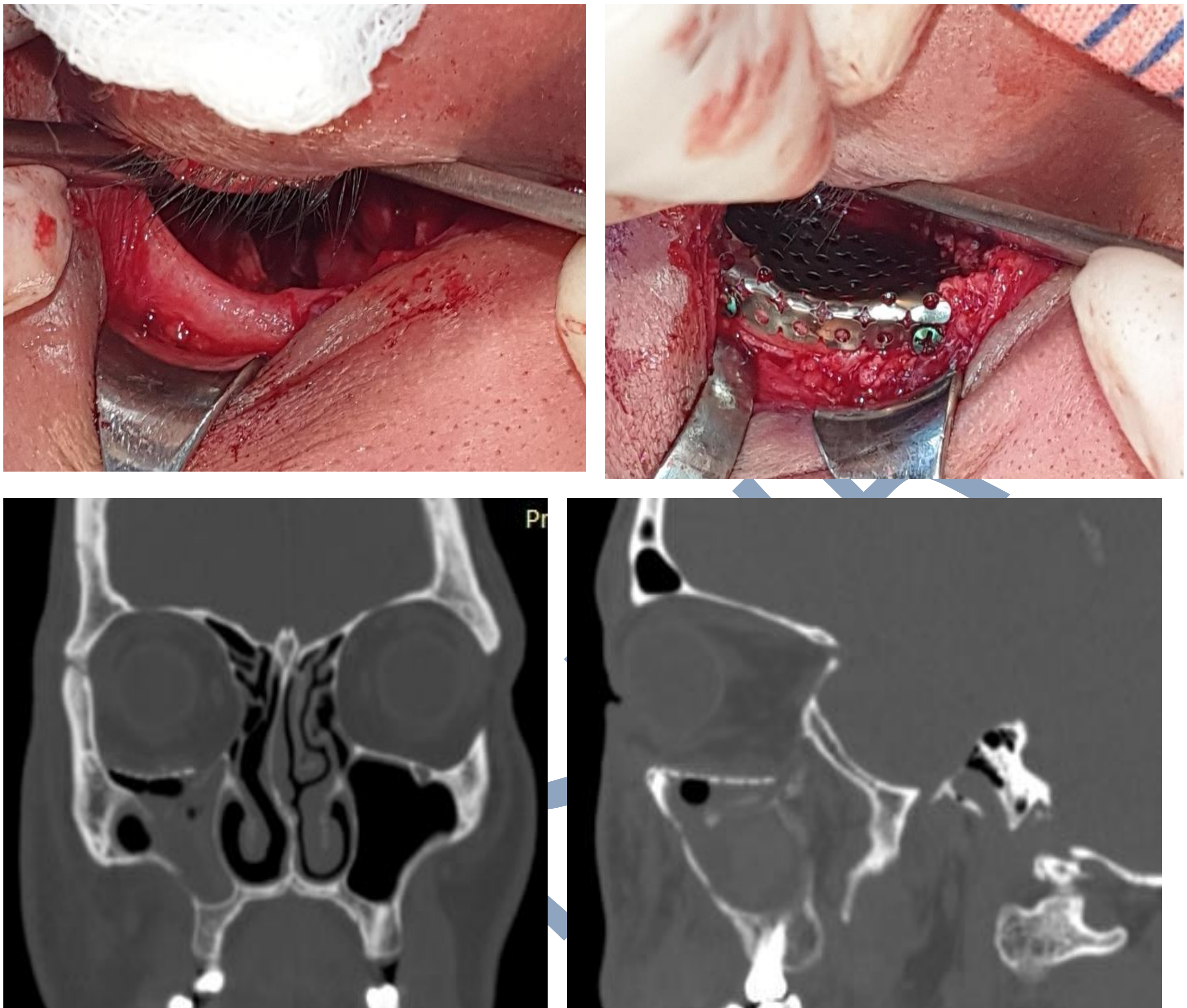
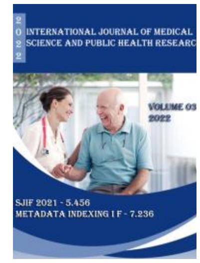


Figure 2. Preoperative preparation, stages of surgery and MSCT of the patient after repair of the defect of the inferior wall of the orbit

Surgical treatment of isolated injuries of the lower wall of the orbit in 32 patients was performed according to the technique developed by us with observance of a number of peculiarities depending on the severity and localization of injuries, as well as the terms of surgical intervention.

The most important stage of the operation was a careful revision of the orbital fractures, release of the pinched oculomotor muscles, elimination of the orbital fiber prolapse, and also the most important is the plasty of the bone defect of the lower orbital wall, relying on the stereolithographic intraoperative template, with the help of which the exact size and shape of the implant and the place of its fixation are determined, and the implant itself is a titanium porous membrane.

The recovery of binocular vision in these patients lasted up to 2-3 months, which was connected with the



nature of eyeball trauma and late terms of surgical treatment.

The duration of hospital stay in the patients of the main group was 3.6±0.2 days. On outpatient treatment of the main group patients were 10,2±0,2 days. The total period of disability in this group of patients amounted to 13,8±0,2 days (Table 1).

Table 1

Duration of disability in comparative aspect (bed-days)

	Main group
Inpatient treatment	3,6±0,2
Outpatient treatment	10,2±0,2
Total period of disability	13,8±0,2

As the above data show, the patients in the main group recovered and returned to work 1.6 times faster compared to the patients in the comparison group.

In the early postoperative period, 3 (10%) patients in the main group had horizontal and vertical diplopia, which was subsequently eliminated by special exercises. Horizontal diplopia was eliminated within 1-1.5 weeks, and vertical diplopia in its extreme leads - 1 month.

CONCLUSIONS

Thus, planning of reconstructive surgical intervention using computer modeling allows the use of stereolithographic intraoperative templates on a 3D printer. This technique contributes to the reduction of surgical intervention time and increases the accuracy of planning and realization of surgical treatment. 3D-planning allows to plan and determine the volume of surgery, implant selection, size and type of implant, as well as its fixation. Thanks to 3D model it is possible to determine the indications and contraindications for surgery, low-traumatic access to the damaged area, in addition, it also allows to avoid postoperative complications such as sensory disturbances in the area of innervation of the suborbital nerve, contracture of the lower jaw, exophthalmos, enophthalmos, diplopia, and others.

REFERENCES

1. Ramponi D.R., Astorino T., Bessetti-Barrett C.R. Orbital Floor Fractures// Adv EmergNurs J. – 2017. - 39(4). – P. 240-247.
2. Reich S.S., Null R.C., Timoney P.J., Sokol J.A. Trends in Orbital Decompression Techniques of Surveyed American Society of Ophthalmic Plastic and Reconstructive Surgery Members// Ophthalmic PlastReconstr Surg. – 2016. - 32(6). – P. 434-437.
3. Schneidera D., Kämmererb P.W., Schönc G. et al. Etiology and injury patterns of maxillofacial

fractures from the years 2010 to 2013 in Mecklenburg-Western Pomerania, Germany: A retrospective study of 409 patients// Journal of Cranio-Maxillofacial Surgery. – 2015. – Vol.43. - №10. –P.1948–1951.

4. Seven E., Tellioglu A.T., Inozu E., Ozakpinar H.R. Reconstruction of Orbital Floor With Auricular Concha// J Craniofac Surg. – 2017. - 28(7). – P. 713-717.
5. Silverman N., Spindle J., Tang S.X., Wu A. et. al. Orbital floor fracture with entrapment: Imaging and clinical correlations in 45 cases// Orbit. – 2017. - 36(5). – P. 331-336.
6. Singh M., Agrawal A., Chaudhary M.et al. Use of three-dimentional plates in mid-face fracture: a prospective study// J Contemp Dent Pract. – 2015. – Vol.16. - №7. – P.571-577.
7. Stathopoulos P., Ameerally P. Reconstructing a Traumatic Empty Orbit: Principles, Difficulties of Treatment, and Literature Review// J Oral MaxillofacSurg. – 2018. - 76(9). – P. 1952 – 1954.
8. Sukegawa S., Kanno T., Katase N., Shibata A. Clinical Evaluation of an Unsintered Hydroxyapatite/Poly-l-Lactide Osteoconductive Composite Device for the Internal Fixation of Maxillofacial Fractures// J Craniofac Surg. – 2016. – Vol.27. - №6. – P.1391–1397.
9. Surgery of Orbital Floor Fractures// J Craniofac Surg. – 2017. - 28(4). - P. 1099-1104.
10. Susarla S.M., Duncan K., Mahoney N.R., Merbs S.L. Virtual Surgical Planning for Orbital Reconstruction// Middle East Afr J Ophthalmol. – 2015. - 22(4). – P. 442-446.
11. The utility of a multimaterial 3D printed model for surgical planning of complex deformity of the skull base and craniovertebral junction / D. Pacione [et al.] // Journal of Neurosurgery. – 2016. – Vol. 125. – № 5. – P. 1194-1197.
12. Vrinceanua D., Banica B. Principles of Surgical Treatment in the Midface Trauma - Theory and Practice // MAEDICA – a Journal of Clinical Medicine. - 2014. – Vol.9. - №4. – P.361-366.
13. Wu P.S., Matoo R., Sun H., Song L.Y., Kikkawa D.O., Lu W. Single-stage soft tissue reconstruction and orbital fracture repair for complex facial injuries// J Plast. Reconstr. Aesthet. Surg. – 2017. - Feb; №70(2). – P. e1-e6.
14. Yilmaz S.Y., Misirlioglu M., Adisen M.Z. A diagnosis of maxillary sinus fracture with cone-beam CT: case report and literature review// Craniomaxillofacial Trauma and Reconstruction. - 2014. -Vol.7. - №2 - P.85-91.
15. Zaleckas L., Pečiulienė V., Gendvilienė I. et al. Prevalence and etiology of midfacial fractures: A study of 799 cases// Medicina. – 2015. – Vol.5. - №1. – P. 222–227.