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Modern Diagnostic Aspects of Fractures of the Naso-Zygomatic-Orbital Complex

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ABSTRACT
This article presents the results of diagnostic aspects and planning of surgical treatment of patients with fractures of the zygomatic-orbital complex. Despite the large number of works devoted to this topic, the literature data concerning the choice of diagnostic methods and planning of surgical treatment are rather fragmentary and not systematized, which in turn allows us to focus activities and research on the development and modernization of methods for diagnosing and surgical treatment of fractures of the zygomatic-orbital complex. In this study, the features of fractures of the zygomatic-orbital complex in 117 patients were studied using modern radiological diagnostic methods. The results of our studies showed that the prevalence of isolated damage to the lower wall of the orbit is 29.3%.

Keywords: Digital Technologies, Zygomatic-orbital Complex, Orbital Wall, Concomitant Injury, Midface, Computed Tomography, 3D Reconstruction.

1. INTRODUCTION

According to the World Health Organization, over the past decade, the number of injuries to the structures of the facial skeleton has increased by 2.4 times. Injuries of the zygomatic-orbital complex (ZOC) are among the most common injuries of the maxillofacial region with a constant upward trend [8].
According to statistics, skull fractures and intracranial injuries account for 5.1% of the total number of all registered injuries according to the rates of injuries and poisonings and other accidents among the adult population [2]. In the structure of general traumatism, 1.7% is occupied by injuries of the eye and orbit [3]. Patients with midface injuries need hospital treatment in 85% of cases [10]. When patients are hospitalized in specialized maxillofacial hospitals, facial skull injuries account for 30%–40%, which is almost 21% of the total number of injured patients in medical institutions [13].
In recent years, there has been an increase in the number of patients with traumatic injuries of the maxillofacial region both in our republic and in other countries of Russia, Europe and the USA. There has been a trend towards an increase in the number of patients with injuries of the middle zone of the facial skull, in particular, fractures of the wall of the maxillary process of the orbit, which is associated with a continuing increase in domestic, transport and industrial injuries [11]. Orbital injury involving the organ of vision and its accessory organs among all injuries of the facial skeleton ranges from 36 to 64% [7]. In the US, about 3% of all emergency room visits are related to eye injuries [12].
To date, radiation diagnosis of traumatic injuries of the midface has evolved from X-ray examination to emergency multislice computed tomography, cone beam computed tomography, the use of specialized models for visualization, planning and design of custom-made implants [1,6].
Combined damage to several anatomical structures, trauma to the eyeball, polymorphism of clinical manifestations, the need to develop optimal surgical treatment tactics require the use of a complex of radiation diagnostic methods [4].
Thus, an increase in the total number of injuries, combined damage to the bone and soft tissue anatomical structures of the middle zone of the face, injuries of the eyeball and its musculoskeletal system dictate the need for timely diagnosis of such conditions for preoperative planning and postoperative control [5, 9].
The aim of this research was to study the diagnostic aspects and features of fractures of the zygomatic-orbital complex.

2. MATERIALS AND METHODS OF RESEARCH

The study is based on examination data of 117 patients with injuries of the zygomatic-orbital complex who were treated in the department of plastic surgery of the multidisciplinary clinic of the Tashkent Medical Academy in the period from 2019 to 2022. The prevailing majority of patients were in the age groups from 21 to 40 years.
Among all patients (n=117; 100%), there was a predominance of males (n=100; 85.5%) over females (n=17; 14.5%). As presented in Table 1, the majority of patients were injured as a result of road traffic accidents (n=71; 60.7%).

Table 1: Distribution of patients depending on age

Age	Total	
	n	%
Less than 20 years old	15	12,8
21-30 years old	45	38,5
31-40	28	23,9
41-50	17	14,5
Over 50 years	12	10,3
Total	117	100

All patients admitted for examination were distributed depending on the time of injury, according to the 3 main stages of the process of formation of post-traumatic deformities (Table 2).
In the acute period (up to 4 weeks), 102 patients (87.2%) were admitted, during the period of emerging post-traumatic deformities (PTD) - up to 3 months after injury - 7 patients (6.0%) were hospitalized, 8 patients (6.8%) applied for examinations.
All patients (n=117; 100%) admitted for examination underwent a collection of complaints and anamnesis, a clinical examination by a maxillofacial surgeon, a neuropathologist and an ophthalmologist, as well as an examination using radiation diagnostic methods.

Table 2: Distribution of patients depending on the time of injury

Term of injury	Total	
	Abs.	%
Acute period	102	87,2
Stage of emerging post-traumatic deformities	7	6,0
Stage of formed post-traumatic deformities	8	6,8
Total	117	100,0

During hospitalization, all patients (n=117; 100%) underwent a diagnostic examination within 24-48 hours from admission.
At the postoperative stage, 117 patients (100%) were examined. Postoperative examination in all patients (n=117; 100%) was carried out within 10 days after surgical treatment as part of early postoperative control and 3-6 months later at the stage of postoperative monitoring.
All patients were consulted by an ophthalmologist and a neurologist, and appropriate drug therapy was carried out. Us in terms of 2 weeks. up to 3 months after the injuries, a comprehensive assessment of the ophthalmological status was carried out using standard methods (visometry, refractometry, tonometry, perimetry, biomicroscopy, ophthalmoscopy). All patients underwent a comprehensive examination of the eyeball and orbit - echography and eyeball biometry (A and B-method), scanning of the orbital space, and one of the most accurate modern methods for assessing the condition of the retina and optic nerve was used - optical coherence tomography (OCT).
In the analysis of 117 radiographs, we obtained general information about the state, position and presence of violations of the integrity of the bone structures of the facial skull in the area of the zygomatic-frontal suture, zygomatic-alveolar crest, alveolar process of the upper jaw, the state of the maxillary sinuses, visualized the complex of zygomatic processes and zygomatic bones.
However, these types of studies reproduce the image in a two-dimensional plane, do not sufficiently affect the state of the walls of the orbit, giving only indirect information about their condition: violation of the integrity of the infraorbital margin, darkening of the maxillary sinus, in some cases blurry visualization of the structures of the orbit.
Multislice computed tomography (MSCT). All patients (n=117; 100%) underwent MSCT during hospitalization using a GE Light Speed 64 machine. Tomography of the facial skeleton was performed with the following parameters: slice thickness - 0.4 mm, slice collimation - 64 * 0.6, mAc / slice - 200, voltage - 120 kV, increment

- 0.6, pitch - 0.5, reconstruction resolution - high, radiation exposure - 0.4 - 0.8 mSv. The patient was placed on the deck of the tomograph table 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 marks were used to accurately determine the scanning area. To mark the study area, a topogram was performed. Tomography was started from the top of the skull to the lower border of the body of the lower jaw (or from the frontal region to the alveolar process of the upper jaw).

3. RESULTS AND DISCUSSION

In the period from 2018 to 2022, 685 patients with injuries of the bones of the facial skeleton were admitted to the TMA multidisciplinary clinic, of which 117 patients had fractures of the zygomatic-orbital complex, which amounted to 17.1% (Table 3).

Table 3: Multislice computed tomography (MSCT)

Of the year	With damage to the bones of the facial skeleton	Fractures of the zygomatic-orbital complex
2018	108	21
2019	102	13
2020	106	12
2021	117	21
2022	144	37

Multislice computed tomography (MSCT) revealed damage to the bone structures of the sculo-orbital complex in all 117 patients (100%).

Changes in the symmetry, position and shape of the injured orbit were determined visually according to CT data in 39 patients (33.3%). In 2 patients (1.7%), a violation of the symmetry, position and shape of both orbits was determined due to a bilateral injury of the middle zone of the face.

Fractures of the inferior wall of the orbit were found in the majority of patients (n=96; 82.1%). Fractures of the lateral wall of the orbit were encountered in 65 cases (55.6%), of the medial wall - in 45 patients (38.5%), of the upper wall - in 23 patients (19.7%). Isolated fractures of one wall of the orbit were noted in 37 patients (31.6%), two walls of the orbit - in 30 cases (25.6%), three walls of the orbit - in 24 cases (20.5%), and fractures of all walls of the orbit were determined in 5 patients (4.3%).

Total fractures of the lower wall of the orbit were found in 22 patients (18.8%). In other cases (n=95, 81.2%), the localization of fractures in the region of the inferior wall of the orbit was distributed as follows. In 47 patients (40.2%), signs of intraorbital emphysema were noted. Table shows the distribution of patients depending on the bone-traumatic injuries of the bones of the middle zone of the face and paranasal sinuses. In most patients, bone-traumatic injuries of the upper jaw were noted, including injuries of the maxillary sinus, alveolar process and teeth. The smallest number of patients had damage to the lacrimal bone (n=26; 22%).

Prolapse of the contents of the orbit into the maxillary sinus was noted in 68.4% of patients (n=80) and had a different degree of severity. Of this contingent of patients, 27.4% (32 patients) had displacement of soft tissues in the maxillary sinus, in 41.0% of cases, displacement of only fatty tissue in the maxillary sinus was observed. Enophthalmos occurred in 12.8% (15) of patients. Damage to the oculomotor muscles was found in 36 patients (30.8%).

Damage by small bone fragments (n=4, 3.4%) and muscle prolapse into the maxillary sinus (n=14, 12.0%) were noted. In 102 cases (87.2%), trauma to the zygomatic-orbital complex was accompanied by emphysema of soft tissues with the appearance of air vacuoles in the cavity of the orbit and soft tissues of the face, edema of the soft tissues of the face (n=102; 87.2%).

Subsequently, we identified 3 groups of patients with traumatic injuries: group 1 - 23 patients (19.7%) with isolated damage to the lower wall of the orbit; - 2nd group - 66 patients (56.4%) with damage to the zygomatic-orbital complex and 3rd group - 28 patients (23.9%) with multiple damage to the bones of the middle zone of the face.

In order to determine the state of the bones of the zygomatic-orbital complex, depending on the time of injury, patients from each group were additionally divided according to the time of admission from the moment of injury to the acute period, the stages of emerging and formed post-traumatic deformities (PTD) (Table 4).

Table 4: Distribution of Patients Depending on the Type of Injury and the Period of Injury at the Preoperative Stage

Admission deadline	Type of damage		
	Isolated damage to the inferior wall of the orbit (Group I)	zygomatic-orbital complex (group II)	Multiple damage to the structures of the middle zone of the face (Group III)

	Abs.	%	Abs.	%	Abs.	%
Acute period	18	78,3	60	90,9	24	85,7
Stage of emerging PTD	3	13,0	2	3,0	2	7,1
Stage of formed PTD	2	8,7	4	6,1	2	7,1
Total	23	100	66	100	28	100

Most patients in the acute period from the moment of injury were admitted with isolated injuries of the inferior wall of the orbit (n=18; 78.3%) and zygomatic-orbital injuries (n=60; 90.9%), in the stage of developing PTD - 7 patients (6, 0%). In the majority of patients in the stage of formed PTD, multiple combined damage to the structures of the middle zone of the face was detected (n=24; 20.5%).

To objectify the diagnosis, we studied the anthropometric parameters of the structure of the walls of the maxillary sinus, taking into account the width and length, and also analyzed the defects of the walls of the orbit (length, width, depth). As the results of the study showed, the width of the maxillary sinus on the affected side in all cases reached the values of the healthy side (3.49±0.07 and 3.61±0.06 cm) and had no significant differences. While the length of the maxillary sinus significantly differed from the parameters on the healthy side (2.87±0.08 versus 3.57±0.07 cm)

As follows from the presented table 5, with this pathology, 100% of patients noted a cosmetic defect, expressed in the retraction of the zygomatic and infraorbital regions. Ophthalmic symptoms were manifested in almost all patients in the acute period of trauma and in most patients with the consequences of orbital damage.

Table 2 systematizes the clinical manifestations of damage to the walls of the orbit. As can be seen from the data, all patients had a cosmetic defect (100%). Ophthalmic symptoms were manifested as oculomotor disorders in 25 (41.9%) cases, eyeball dystopia and limitation of eyeball movements occurred in 18 (29%) cases. When studying the position of the eyes in the orbit, it was revealed that in 29 patients (46.7%) the eyes had the correct position, in 18 (29%) cases they were displaced downwards. Enophthalmos and exophthalmos occurred in 16.1 and 8.06% of cases, respectively.

Table 5: Clinical Manifestations of Damage to the Walls of the Orbit in Patients

Symptoms	**number of patients**	**percentage characteristic**
cosmetic defect	62	**100%**
Ophthalmic symptoms:		
Oculomotor disorder	26	41,9%
Dystopia of the eyeball	18	29%
limitation of eyeball movements	18	29%
The position of the eyes in the orbit		
Correct position	29	46,77%
Offset to the bottom	18	29,03%
enophthalmos	10	16,12%
exophthalmos	5	8,06%
Visual acuity with maximum correction:		
Visus=1,0	42	67,7%
Visus=0,7-0,9	15	24.2%
Visus=0,5-0,6	5	8,1%
Fundus changes:		
Angioretinopathy	14	22,58
Edema of the optic nerve	5	8,1%
Anterior ischemic neuropathy	4	6,5%
Posterior ischemic neuropathy	2	3,2%
Berlin’s retinal opacities	1	1.6%

In the study of vision with maximum correction, it was found that in 42 patients (67.7%) - Visus = 1.0, in 15 (24.2%) - Visus = 0.7-0.9, in 5 patients (8, 1%) visual acuity was equal to the range of 0.5-0.6.

4. CONCLUSION

Thus, the examination made it possible to: clarify the location and nature of the damage, assess the condition of the oculomotor muscles, the position of the eyeball, detect prolapse of the orbital tissue and clarify the size of the defect in the walls of the orbit, which is especially important for choosing an orbital implant and planning surgical intervention. The tactics of managing patients included 2 main areas: surgical treatment with the choice of an implant in accordance with the calculated volume and area of the defect, prosthetics of the lower wall with

implants in accordance with the size of the defect with the addition of elements of metal osteosynthesis (MOS) in the region of the structures of the middle zone of the face.

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