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EPIDEMIOLOGY, CLASSIFICATION, CLINIC AND DIAGNOSIS OF ORBITAL FRACTURES IN BLUNT INJURY

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Annotation

In this article, contusion injuries of the orbit are particularly severe, with a high risk of blindness, purulent-inflammatory complications, the possibility of developing functional and cosmetic defects, and the bones of the middle zone of the facial skeleton are also involved in the formation of the orbit, so Injuries in this zone are detailed information about the damage to the bony walls of the orbit!

Keywords: Eye, Injury, blindness, orbit, prevention, treatment, prevention.

Contusion injury of the orbit is particularly severe, with a high risk of blindness, the possibility of developing purulent-inflammatory complications, functional and cosmetic defects [1]. The multiple nature of traumatic injuries leads to the need to use accurate topical diagnostics and plan treatment. The study of traumatic injuries of the orbit is relevant.

Epidemiology of orbital injury. Orbital injury due to contusion among all injuries of the facial skeleton involving the organ of vision and its auxiliary organs ranges from 36 to 64% [1, 2]. Of all orbital injuries requiring inpatient treatment, about 85% are violations of the integrity of the bone walls [3].

According to epidemiological studies in Russia, there is an absolute predominance of domestic (64.5%) orbital injuries over criminal (21.7%) and industrial (15.5%) injuries [1, 4]. This pattern is due not so much to a decrease in the number of criminal and industrial injuries of the orbit as such, as to the fact that in many cases they are recorded from the patient's words as everyday ones [5].

Many authors note an increase over the past 5 years of traffic injuries of the orbit from 4.9% in 2007 to 12.8% in 2010, which is associated with a quantitative increase in vehicles, high speeds on the roads, drinking alcohol while driving [2, 6 , 7].

Orbital injuries are often the result of sports [3]. According to the staff of the Department of Ophthalmology of the Perm Medical Institute for 10 years (2000–2010), sports injuries account for 9–11% of bone fractures in the middle zone of the facial skeleton [8].

The bones of the middle zone of the facial skeleton are also involved in the formation of the orbit, so injuries in this zone are reflected in the nature of damage to the bone walls of the orbit. Fractures of the middle zone of the face in 80% of cases are combined with fractures of the orbit [4], of which the most common are isolated fractures of the inferior wall of the orbit, accounting for 6–12% [9]. In 29 - 37% of patients, damage to two walls of the orbit was determined. Fracture of three walls of the orbit was registered in 12-18% of patients and all four - in 3-7% of patients. In the structure of all diseases of the orbit in peacetime, damage to the orbit is, according to the Military Medical Academy of St. Petersburg (VMA St. Petersburg), from 2 to 8% [4], in children - 0.9% [10]. In children, fractures of the bony walls of the orbit due to blunt trauma account for 23% of all facial injuries.

Of all orbital fractures encountered in pediatric practice, from 25 to 70% are injuries of the lower wall in the variant of a linear fracture without displacement of fragments - like a “trap” with infringement of the inferior rectus muscle [3, 11]. Damage to the orbit is combined with damage to the ENT organs in 92%, the maxillofacial region - in 47%, the bones of the skull and brain - in 45%, and other organs - in 11% of cases according to the Military Medical Academy of St. Petersburg. In 65–66% of cases, orbital injuries are combined with contusions of the eyeball and its auxiliary organs [4, 12]. In the literature on ophthalmology, contusion of the soft tissues of the orbit is distinguished without a fracture of the bone walls and with a fracture [13]. In most cases, contusion injury of the orbit is unilateral; bilateral injuries are less common. In terms of the frequency of occurrence, fractures of the bone walls of the orbit during orbital contusion are one of the most common injuries of the middle zone of the face and account for

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31% [3]; in children - 23% of all injuries of the left skeleton [10]. Orbital contusions without fracture occur in 78% of all orbital injuries [13].

The social significance of orbital injuries is determined by the young working age of patients, while there is a bimodal distribution of orbital contusion with frequency peaks at the age of 16–21 and 39–55 years, a decrease in adaptation to work in the presence of diplopia in 89% due to this, significant economic losses [6 , fourteen].

A significant difference was determined in the distribution of orbital contusion injury by sex: three quarters of the victims were men [3].

The possibility of seasonal dependence of the frequency of orbital injuries was also studied. Thus, it was noted that the number of fractures of the bone walls of the orbit increases sharply in the period from April to October; according to other sources, this occurs in the period from July to September [2].

Analyzing the contingent of victims with orbital trauma, it was found that in 42% of cases, patients at the time of injury are in a state of alcoholic intoxication [3].

Classification of traumas of an orbit. According to the classification of Gundorova (2009), by causality, orbital injury is divided into household, transport, criminal, industrial, sports, agricultural, technogenic, and children's [1].

In the literature, the only complete classification of orbital fractures was proposed by Nikolaenko V.P. (2009), according to which the most common types of orbital fractures were identified, which can occur in isolation or in various combinations with other facial injuries.

- - "explosive" and depressed fractures of the lower wall of the orbit;
- - "explosive" and depressed fractures of the inner wall of the orbit;
- - fractures of the zygomatic-orbital complex;
- - fractures of the upper jaw according to Le Fort type I, II, III *;
- - nasoethmoidal fractures;
- - "explosive" and depressed fractures of the upper wall of the orbit;
- - frontobasal fractures (including supraorbital, glabellar, and isolated fractures of the upper edge of the orbit);
- - fractures of the apex of the orbit, including those with concomitant damage to the optic nerve canal;
- - local fractures caused by sharp objects stuck into the orbit.

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*Upper jaw fractures account for 2–5% of all facial fractures. The most common classification of fractures of the upper jaw according to LeFort (1901). It distinguishes three main types of fracture [3].

Lower (Lefort-I; transverse). Its line runs in a horizontal plane. Starting at the edge of the piriform opening on both sides, it goes posteriorly above the level of the bottom of the maxillary sinus and passes through the tubercle and the lower third of the pterygoid process of the sphenoid bone.

Medium (Lefort-II; suborbital). Its line passes through the junction of the frontal process of the maxilla with the nasal part of the frontal bone and nasal bones (nasofrontal suture), then goes down the medial and lower walls of the orbit, crosses the bone along the infraorbital margin and reaches the pterygoid process of the sphenoid bone. The ethmoid bone with the cribriform plate is often damaged.

Upper (Lefort-III; subbasal). Its line passes through the nasofrontal suture, along the inner and outer walls of the orbit, reaches the upper part of the pterygoid process and the body of the sphenoid bone. At the same time, the zygomatic process of the temporal bone and the nasal septum are fractured in the vertical direction. Thus, the facial bones are separated from the bones of the skull.

The orbit is damaged in subbasal and suborbital fractures. Traumatic injuries of the upper jaw according to the LeFort classification are bilateral, and their lines are symmetrical. The typical location of the fracture lines is rare, more often the fracture line is atypical or asymmetrical [13].

In scientific works, the main attention is paid to the lower wall, since it is most often damaged by trauma to the orbit.

According to the classification of A. S. Kiselev (2006), types of "explosive" fractures of the lower wall of the orbit were distinguished:

- - finely splintered, when the lower wall of the orbit "crumbles" into a large number of small fragments and is practically absent in a certain area, depending on the fracture;
- - large fragments, consisting of one or two large fragments that descend into the cavity of the maxillary sinus along with the tissues of the orbit;
- - folded, fragments do not lose contact with the bone and tend to return to their original position, infringing on the orbital tissues wedged between them.

In addition, Professor V.P. Ippolitova (2004) developed a classification of post-traumatic deformities of the middle zone of the face based on the clinical and radiological picture of damage to the zygomatic-orbital complex (SOC). M. M. Khitrina (2007), based on her classification, compiled a working scheme of fractures of the zygomatic-orbital region (SOO), features:

Excludes the term "fracture of the zygomatic bone", since always the lines of fractures are localized outside the zygomatic bone with involvement of the edges and walls of the orbit in the process.

It takes into account the multiple nature of fractures of the SOC and highlights the localization of the maximum displacement and diastasis, which facilitates the choice of the method of surgical treatment.

5 Groups of Fractures

- 1. MCS fractures with maximum displacement of fragments and diastasis along the infraorbital margin.
- 2. MCS fractures with maximum displacement of fragments and diastasis along the zygomatic-frontal suture.
- 3. Multiple MCS fractures without pronounced diastasis between fragments.
- 4. Fractures of the MCS, combined with fractures, a defect in the bottom of the orbit.
- 5. Fractures of the zygomatic arch [15].

According to the working classification of Gorbunova E. D. (2006), fractures of the lower wall of the orbit in children according to clinical and radiological signs: the presence and timing of the disappearance of diplopia, limited mobility of the eyeball, the transverse size of the through defect, the magnitude of the displacement of the lower wall of the orbit towards the maxillary sinus, the presence computed tomographic signs of infringement of the soft tissues of the orbit in the area of the fracture.

- 1. CT - signs of a fracture with a transverse size of a through defect up to 0.5 cm and a minimum displacement of the lower wall of the orbit up to 0.2 cm without signs of infringement in the area of fracture of the soft tissues of the orbit. Clinical signs (diplopia, limited mobility) disappear on the 2nd - 5th day.
- 2. CT - signs of a fracture with a transverse size of a through defect of more than 0.5 cm and a displacement of the lower wall of the orbit of more than 0.2 cm without signs of infringement in the zone of fracture of the soft tissues of the orbit. Clinical signs (diplopia, limited mobility of the eyeball) disappear on the 7th - 10th day.

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- 3. CT - signs of a fracture with infringement of the contents of the orbit and its prolapse into the maxillary sinus. Clinical signs (impaired mobility of the eyeball, doubling, enophthalmos, including progressive) persist without dynamics [10].

Definition and mechanism of orbital contusion injury. Orbital contusion is a closed, without violating the integrity of the skin, damage as a result of blunt force acting on the bone walls of the orbit and its contents (contusion, compression) [1].

Blunt trauma to the orbit occurs as a result of a blow in which the traumatic object is in motion: a blow with a fist, a leg, a stick, a log, a puck, a ball, a swing; or in which the object of influence remains motionless: falling to the ground from a height (from a tree, a bicycle), an accident [11, 13]. A detailed assessment of the mechanism of orbital injury during contusion helps in making the diagnosis. So, if the area of a blunt solid object is less than the size of the entrance to the orbit, the patient may develop a subconjunctival rupture of the sclera without damaging the bone walls of the orbit. If the dimensions of the damaging object are larger than the dimensions of the orbital entrance, two options are possible: under the influence of an agent with a relatively low speed and low kinetic energy, an "explosive" fracture of the orbital wall (lower or internal) occurs; with a strong blow, a combined fracture (of the lower orbital margin and the bottom of the orbit or the inner wall; of the upper orbital margin and the inner wall, the roof of the orbit) [1].

If the object of impact is large, has high kinetic energy, then it causes a fracture not only of the "bone ring" of the orbit, but also of other bones of the face, up to the formation of panfacial fractures [3].

Types of damage during contusion of the orbit are determined by the condition of the eyeball and the anatomical features of the structure of the orbit. If the outer membranes of the eye are defective, for example, after keratotomy or with scleromalacia, the "capsule" of the eye ruptures and this "saves" from a fracture. A normal eyeball during contusion does not break from a blunt flat impact, but is deformed and displaced deep into the orbit, compressing its contents and sharply increasing intraorbital pressure, which causes the weakest lower wall of the orbit to be forced into the maxillary sinus [3, 15, 16]. The anatomical structure of the lower wall of the orbit - a thin periosteum, the cellular structure of the spongy substance and the topographic location - the nodal position in the system of natural bone joints of the orbit, determine the high incidence of single and combined fractures in 87.3%. Less common are fractures of the outer, upper, inner walls, isolated and combined - 15.8% [1, 9].H. Takizawa et al. (1998), based on experiments and subsequent computer simulations, demonstrated that the contour (profile) of the orbital walls plays an important role. In particular, the arcuate roof of the orbit is much more resistant to deformation than the almost flat bottom, which is more easily deformed and broken.

The inner wall of the orbit is even thinner, but behind it, like buttresses, cells of the ethmoid labyrinth strengthen it, so more mechanical energy is required to fracture the medial wall than to fracture the bottom of the orbit [3, 13]. Also, reflex contraction of the circular muscle of the eye and the presence of a large air cavity under the orbit contribute to more frequent damage to the lower wall of the orbit [17]. It is the underdevelopment of the maxillary sinus and the continued growth of the orbit that explains the rarity of orbital floor fractures in children under 7–8 years of age [3,18].

With “direct” fractures, the zygomatic bone is damaged, which “breaks out” along the seams connecting it with the frontal, temporal and maxillary bones. The entire impact force falls on the edges of the orbit, causing their fracture or ending with the formation of fragments in the injury zone, or extending deep into the walls. Such a fracture is accompanied by an almost complete loss of the lower wall of the orbit [19].

The clinical picture of orbital injury in case of contusion in the acute period is determined by the localization of the fracture of the orbital bone wall. The symptoms of a fracture of the lower wall of the orbit are well described: edema, hematoma of the eyelids, hyposphagma, chemosis of the bulbar conjunctiva, downward displacement of the eyeball (hypophthalmos), limitation of the volume of active and passive eye movements, impaired sensitivity in the zone of innervation of the infraorbital nerve [1, 3].

The symptoms of a fracture of the inner wall of the orbit are not as clear as with a fracture of the lower wall: emphysema of the eyelids, conjunctiva, unilateral epistaxis. A fracture of the inner wall of the orbit revealed enophthalmos with entrapment of the internal rectus muscle in the fracture zone [9, 20]. With this type of fracture, the medial ligament of the eyelids, the lacrimal canaliculi, and the lacrimal sac can also be damaged [1].

With a fracture of the upper wall of the orbit, along with a severe general condition of the patient, there are often violations of the movement of the eyeballs, the syndrome of the superior orbital fissure, pulsating exophthalmos, anisocoria due to impaired pupillary innervation, damage to the optic nerve in the bone canal, the optic nerve pathway, liquorrhea, "symptom points" [1, 21].

Symptoms of a fracture of the outer wall of the orbit, which includes the zygomatic complex (asymmetry of the face, violation of the contour of the zygomatic bone, limitation of the range of motion of the lower jaw to the sides and down when opening the mouth). Also, displacement of the eyeball, limitation of the volume of active and passive movements, damage to the outer commissure of the eyelids [1, 13].

The complexity of the clinical examination of a patient with an orbital injury is due, on the one hand, to the uniformity of clinical symptoms in various injuries of the orbit and optic nerve, on the other hand, the inaccessibility of the orbit for examination and the limited known research methods, as well as the complexity of differential diagnosis with intracranial injuries and damage to the optic pathway [3].

Clinical examination of a patient with damage to the bone structures of the orbit allows you to get an approximate idea of the nature and extent of damage to the orbit. Related to this is the importance of the stage of radiation diagnostics, whose tasks are to clarify and confirm the clinical diagnosis, develop optimal treatment tactics, and determine the prognosis for orbital contusion [1, 22].

Diagnosis of orbital injury in case of contusion is difficult due to the need to use various instrumental methods for examining the orbit [3]. The leading method for studying the state of the orbit is beam diagnostics. Diagnosis of traumatic injuries of the bone structures of the orbit begins with traditional x-ray of the skull in frontal, lateral and anterior semi-axial projection or x-ray of the orbits in 2 projections. If damage to the posterior wall of the orbit, canal of the optic nerve, frontal, ethmoid bone is suspected, a targeted radiography of the orbit area is performed according to the method of O. Rhese (1911) or an x-ray of the superior orbital fissure is performed [1, 13].

According to various authors, numerous and time-consuming X-ray studies do not have the proper information content, often misleading the doctor and significantly delaying the diagnosis. The probability of error (missed fracture on x-ray, diagnosed by subsequent coronary computed tomography) is 10–13% for the inferior wall and 20–27% for a fracture of the inner wall. However, radiography is 100% effective in diagnosing a fracture of the upper and outer wall of the orbit [3, 10, 22, 23, 24]. Therefore, at present, radiography in the scope of survey studies of the skull and orbit in frontal, lateral and anterior semi-axial projections is used only at the stage of patient admission as a screening method. When analyzing the obtained radiographs, attention is mainly paid to indirect signs of damage to the orbit: darkening of the orbit due to pronounced swelling of the eyelids and retrobulbar tissue in the area of damage, air in the upper parts of the orbit.

X-rays can be used to diagnose gross fractures of the orbital walls, large bone fragments, and hemosinus due to darkening of the paranasal sinus adjacent to the fracture zone [22].

The disadvantages of the method are the inability to assess the changes and interposition of the soft tissues of the orbit with bone structures (infringement, change in shape, muscle ruptures), to determine the extent of the fracture towards the top of the orbit, the width along the entire length. When radiography occurs, projection layering of bones, therefore it is impossible to get an idea of small fractures with the formation of small fragments or cracks in thin bones, comminuted fractures without significant displacement, to establish the presence of penetration of bone fragments into the cranial cavity, paranasal sinuses. With the help of radiography, it is impossible to assess and decide on the need for surgical intervention [6, 10, 23].

Traditional radiography can be limited only to ascertaining an extensive fracture of the orbit in an appropriate clinic.

With a positive conclusion of the traditional X-ray examination and when the radiologist gives a negative conclusion, and the clinician's suspicions remain, the patient is referred for computed tomography (CT) for a detailed diagnosis of the features of damage to the orbit during contusion [19]. The reality of our time is emergency CT as the method of choice. Although the optimal time for CT is considered to be a delayed period after an orbital injury (decrease in soft tissue edema) [3, 25].

The advantage of CT research is the ability to differentiate tissues of different density due to high resolution (to determine the state of the bone structures of the orbit, the contents of the eye cavity and orbit), as well as non-invasiveness, low time and financial costs.

In addition, according to computed tomography data, it is possible to clearly visualize small and combined (several walls) fractures, assess the size and position of bone fragments, diagnose such complications of contusion injury as retrobulbar, subperiosteal hematoma, hemorrhage in the intrathecal spaces of the optic nerve, extraocular muscles, identify the condition of the mucosa membranes of the paranasal sinuses (signs of hemorrhage, inflammation) [3, 10]. A significant disadvantage of the CT method, especially multiple, is the radiation exposure to the lens [3, 26].

For a complete analysis of damage to the bone orbit and its contents, the study is performed in two planes with a step of 1.25 mm. Coronary (frontal) tomograms are more informative in the analysis of deformation, defects of the lower and upper walls of the orbit, prominence of an orbital hernia into the maxillary sinus or cerebral hernia into the orbit, rupture and fusion of extraocular muscles with bone. Axial sections better visualize fractures of the medial and lateral walls of the orbit, optic nerve, and optic nerve canal, as well as the shape of the rectus extraocular muscles [26, 27].

When analyzing CT data for unilateral fractures, attention is paid to the symmetry of the shape and volume of the orbits, the position of the eyeballs and extraocular muscles, the state of the optic nerve and its bone canal, and the presence of foreign bodies [1, 28].

In case of bilateral fractures, the shape of the orbits as a whole, fractures of its walls and edges, and the position of soft tissues are assessed in comparison with normal anatomy. Normally, the eyeball occupies a central position in the orbit, its displacement close to any wall indicates the infringement of the corresponding muscle in the fracture zone. The shadows of the rectus muscles are normally located at a distance of 0.1-0.3 cm from the bone walls - if there is no X-ray negative strip between the muscle and the bone, we suspect cicatricial fusion of the muscle with the bone or its infringement [3, 10, 26].

Large-comminuted fractures in fractures of the middle zone of the face often affect the zygomatic, frontal bones and the upper jaw.

Small comminuted fractures are typical for "explosive" fractures of the orbit with damage to the thin bones of the ethmoid labyrinth or the lower wall of the orbit.

Fissure fractures are commonly found in burst fractures (lower wall fissure) and frontal bone fractures (upper wall fissure).

CT scan helps to identify secondary involvement of the lower and internal rectus muscles near the displacement of bone fragments in case of “explosive” fractures of the walls of the orbit, differentiates the causes of diplopia due to muscle infringement and the development of muscle hematoma, helps to identify parabulbar soft tissues prolapsed into sinuses adjacent to the orbit [1, 27, 28].

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Obtaining coronary images can be prevented by the severe general condition of the patient, the presence of an endotracheal tube in the trachea (its image is superimposed on the contours of the orbit), or a neck injury that prevents its hyperextension. In these cases, the method of spiral computed tomography (SCT) or multi-detector spiral computed tomography (MSCT) is indispensable, which are distinguished by high diagnostic information content, scanning speed, the possibility of imaging orbits in bone and soft tissue modes, creating three-dimensional and multiplanar reformations based on multiple slices - scanning with high frequency. In addition, there is no need for neck hyperextension to obtain coronal sections [29, 30].

Many authors argue that the methods of CT and MSCT will eliminate the need for magnetic resonance imaging (MRI) in patients with orbital trauma. However, the use of these methods in the diagnosis of orbital contusion injury in the literature is represented by single authors [31].

In addition, the staff of the Department of Radiation Diagnostics of the First Moscow State Medical University. Sechenov developed a method of non-invasive low-dose (2 mSv) functional MSCT (fMSCT) of extraocular muscles in orbital trauma.

The study is carried out in the dynamic scanning mode according to the program of bone and soft tissue reconstruction with a slice thickness of 0.5 mm in axial projection, followed by obtaining multiplanar and three-dimensional reconstructions with simultaneous eye movement in a certain sequence. When performing fMSCT in the presence of functional activity of the muscle, fixation of the extraocular muscle in the fracture zone can be detected. In the absence of muscle movements and contractility, confirm paralysis of the nerves involved in muscle innervation or diagnose muscle detachment from the eyeball, from the top of the orbit [32].

MRI plays an auxiliary role in the diagnosis of orbital trauma in case of contusion, which is explained by poor visualization of bone fragments, long scanning time, and high cost. The use of MRI for diagnosing orbital injury is limited by numerous contraindications - the patient has a pacemaker, metal implants, permanent makeup and tattoos (creating artifacts and making it difficult to interpret images), claustrophobia, pregnancy and lactation, uncontrolled patient movements during the study.

At the same time, the undoubted advantages of MRI - good visualization of soft tissues and the absence of radiation exposure - allow the use of nuclear -

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magnetic resonance to assess the possible residual infringement of the extraocular rectus muscles or orbital tissue in the fracture zone, the diagnosis of carotid-cavernous anastomosis, the analysis of exudate accumulation in the orbit and subperiosteal space, the dynamics of the transformation of methemoglobin into hemosiderin (evolution of the orbital hematoma).

MRI makes it possible to assess the anatomical and topographic correlation of the structures of the orbit with the paranasal sinuses and the brain [1, 31].

Ultrasound examination (ultrasound; two-dimensional imaging system) of the structures of the orbit and eyeballs in case of orbital contusion, allows you to see the section of the eye in a given scanning plane with its structural changes. With the help of ultrasound, it is possible to assess the shape, size, clarity of contours, structure, echogenicity of the eyeballs, as well as the location and size of the main intraocular structures: cornea, anterior chamber, iris, ciliary body, lens, vitreous body, retina, choroid; the state of the optic nerve area, retrobulbar space, extraocular muscles [32, 33].

In recent years, ultrasound diagnostics of orbital fractures in case of orbital contusion injury has been actively introduced [34]. The main arguments are economic feasibility, the widespread use of ultrasound equipment, the absence of radiation exposure and the possibility of a long-term study. The most justified was the use of ultrasound for the diagnosis of fractures of the lower edge and anterior parts of the orbital floor, the technique was proposed by Medvedev Yu.A. and Konyakhin A.F. (2007). The principle of the method is that a diagram of the location of ultrasound sensors is applied to the patient's face to examine the bone tissue along the entire fracture line on the injured side and the same volume of bone tissue on the undamaged side, taking into account the complex relief and anatomical and topographic structure of the bones of the middle zone of the face. Based on this method, it was determined that the speed of the ultrasound signal is slower on the injured side compared to the healthy side, in dynamics the line of injury approaches the indicators of the healthy side. Dynamic studies allow obtaining data on the course of reparative processes along the fracture line, making it possible to timely switch to functional treatment, evaluate one or another method of fixing bone fragments, and reduce the number of x-ray studies [35].

In conclusion, it can be noted that the incidence of blunt orbital trauma among all injuries of the facial skeleton involving the organ of vision and its accessory organs ranges from 36 to 64%. In the early stages, the uniformity of clinical symptoms does not allow an accurate topical diagnosis.

To diagnose the localization of the site of damage to the orbit, different diagnostic methods are currently used (X-ray, CT, MSCT, fMSCT, MRI, ultrasound). However, the published materials do not indicate clear indications for the use of each of these methods. To systematize and build an effective targeted algorithm for examining patients with blunt orbital trauma is the task of our further research.

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