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MODERN APPROACHES TO SURGICAL TREATMENT OF INFERIOR ORBITAL WALL FRACTURES

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Abstract. *This study presents a summary of our clinical experience in the surgical rehabilitation of patients with inferior orbital wall fractures. A comprehensive clinical and radiological examination was conducted both preoperatively and postoperatively in 14 patients diagnosed with orbital floor injuries. These fractures were observed both in isolated cases and in combination with zygomatic-orbital complex fractures. Analysis of the cases revealed that isolated inferior orbital wall fractures accounted for 57.14% of the total, with the predominant patient group being young males (78.57%).*

During surgical treatment, a transantral approach was utilized in all cases, providing optimal access to the inferior orbital wall. In instances where the orbital floor fracture was associated with a zygomatic-orbital complex injury, not only was the orbital floor repositioned, but the zygomatic complex was also stabilized at three standard anatomical fixation points. In cases of isolated injury, characteristic of the so-called pure "blow-out" fracture, the technique of bone-plastic antrotomy was employed as a variation of the transantral approach, allowing for the prevention of a defect in the anterior wall of the maxillary sinus.

For osteosynthesis, titanium materials were used in all clinical cases, including F-shaped miniplates or individually contoured titanium meshes, particularly in cases of significant bone defects. As a result of the surgical intervention, all patients achieved restoration of both functional and aesthetic parameters disrupted by the trauma. Long-term outcomes demonstrated complete recovery of binocular vision and the absence of enophthalmos, confirming the high efficacy of the proposed approach.

Keywords: *orbital floor fractures, zygomatic-orbital fractures, transantral approach, bone-plastic antrotomy.*

Relevance. Historically, the first description of an inferior orbital wall fracture was provided by MacKenzie in Paris in 1844. The term blow-out fractures entered medical practice in 1957 when Smith and Regan presented a clinical description of an inferior orbital wall fracture with interposition of the inferior rectus extraocular muscle and restriction of ocular motility.

It is generally accepted that the mechanisms underlying blow-out fractures are associated with the impact of a blunt object on the anterior parts of the orbit. The most common traumatic agents include punches, elbows, or sports equipment (such as balls). In this case, the force is transmitted from the orbital rim and the eyeball to the inferior orbital wall, leading to its damage at the thinnest site, most often in the medial zone near the infraorbital canal.

As a result of a sharp increase in intraorbital pressure, the bony structure is destroyed, accompanied by prolapse of soft tissues into the lumen of the maxillary sinus. In some cases, interposition of the inferior rectus or inferior oblique extraocular muscle occurs along the fracture line, which, along with edema of the surrounding tissues, causes restriction of ocular motility and, as a result, the development of diplopia.

Isolated fractures of the medial orbital wall are significantly less common and, as a rule, are part of more complex injuries, particularly naso-orbito-ethmoidal complex trauma.

The clinical picture of most patients with inferior orbital wall fractures includes decreased visual acuity, blepharoptosis, as well as the development of vertical or oblique diplopia, which is most pronounced when looking upward. Additionally, hypoesthesia in the infraorbital nerve distribution is noted, caused by its compression or injury. Characteristic signs also include periorbital hematoma and pronounced edema, accompanied by pain. In the early days following trauma, the presence of enophthalmos may remain unnoticed due to significant swelling of the surrounding tissues, which can also restrict ocular movement, creating a false impression of extraocular muscle interposition in the fracture zone.

The treatment strategy is determined by the time elapsed since the injury and continues to be a subject of discussion among researchers. Most authors agree that the optimal window for surgical intervention is up to 14 days, as later surgery is associated with the risk of developing fibrotic changes and persistent deformities due to contractures of soft tissues. In some cases, before performing surgery, physicians prefer to wait several days, during which edema and hematoma significantly subside, allowing for a more accurate assessment of enophthalmos severity and the functional state of the extraocular muscles. If interposition of the inferior rectus muscle is detected during this period, an urgent surgical intervention is performed, preferably within the first 7 days, to prevent residual muscle dysfunction.

One of the key diagnostic methods for fractures is radiological examination. Performing X-ray imaging of the facial skeleton in a semi-axial projection allows for assessing the extent of orbital floor damage, soft tissue prolapse into the maxillary sinus, and the presence of a fluid-air level in the maxillary sinus, which may indicate a hemosinus. However, the most accurate and detailed information about the nature and severity of the injury is provided by computed tomography (CT). CT scanning enables a comprehensive evaluation of both bone and soft tissue structures, making this method the gold standard in the diagnosis of orbital trauma. Compared to conventional X-rays, CT offers superior resolution, particularly in detecting small bone fragments, fractures with minimal displacement, and soft tissue entrapment, which are crucial factors for determining treatment strategy.

The choice of treatment approach depends on the clinical presentation of the injury. Conservative management is considered appropriate for patients in whom enophthalmos does not exceed 2 mm, there is no entrapment of the inferior rectus muscle, and diplopia is absent. In such cases, pharmacological therapy is administered, which includes a course of antibiotics to prevent infectious complications and a short-term regimen of corticosteroids to reduce inflammatory

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edema. Additionally, patients are often advised to maintain head elevation, use cold compresses, and avoid physical exertion that could exacerbate orbital pressure.

According to literature data, surgical treatment of orbital floor fractures can be performed using various techniques. The most commonly used surgical approaches include:

- Subciliary approach – An incision is made 2–3 mm below the lower eyelid margin, providing excellent exposure of the surgical field. This approach is commonly used in cases requiring wide access for fracture reduction and implant placement.
- Transconjunctival approach – Performed through the conjunctiva of the lower eyelid, sometimes supplemented by lateral canthotomy. The advantages of this method include the absence of visible external scars and a reduced risk of postoperative lower eyelid retraction. However, it may limit surgical access in cases of extensive fractures.
- Transantral approach – The orbital floor is accessed through a bony window created in the anterior wall of the maxillary sinus, allowing minimization of peri-orbital tissue trauma. This method is particularly effective in posteriorly located fractures or when simultaneous sinus surgery is required.

In addition to traditional surgical techniques, endoscopic technology has been increasingly utilized in the surgical treatment of orbital floor fractures. This method is particularly attractive due to its minimally invasive nature and ability to provide magnified visualization of the surgical field. However, its application is limited in cases of complex fractures with significant bone defects and extensive soft tissue displacement, where a more direct and stable reconstruction is required.

In reconstructive surgery, a wide range of implants is available for orbital floor defect repair. The most commonly used materials include synthetic implants, such as polyethylene, silicone, and titanium miniplates, as well as resorbable implants that provide temporary structural support and are gradually replaced by the patient's own tissues over time. These materials offer high mechanical strength and biocompatibility, making them suitable for long-term restoration of the orbital floor.

Additionally, autogenous bone grafts harvested from various anatomical sites of the patient serve as an alternative option for reconstruction. Frequently used donor sources include fragments of the anterior wall of the maxillary sinus, bone plates from the skull vault, or cartilaginous elements from the nasal septum. These biological materials demonstrate excellent biocompatibility, low risk of rejection, and high osteointegration capacity, making them the preferred choice in select clinical cases, particularly in patients requiring long-term stability and natural tissue incorporation.

Materials and methods. From 2022 to 2025, in the Multidisciplinary Clinic of Tashkent Medical Academy, at the Department of Plastic Surgery, we treated 14 patients aged 27 to 48 years (11 men and 3 women) diagnosed with inferior orbital wall fractures.

All patients underwent comprehensive clinical and radiological examinations. Initially, standard radiographic studies of the facial skeleton were performed in a semi-axial projection. In cases where clinical and radiological findings suggested a possible orbital floor fracture, computed tomography (CT) in two projections was conducted. This allowed for a more precise assessment of the extent of bone and soft tissue damage, the presence of orbital content prolapse, and possible entrapment of the inferior rectus muscle.

Patients were categorized into two groups:

- Group 1 – 8 patients with isolated blow-out type orbital floor fractures.
- Group 2 – 6 patients with orbital floor fractures combined with zygomatic-orbital complex injuries.

In all cases, surgical treatment was performed using a transantral approach. In patients with combined trauma, in addition to orbital floor repositioning, the zygomatic complex was fixed with titanium miniplates at three standard anatomical points:

1. Inferior orbital rim
2. Zygomatic-alveolar crest
3. Zygomatic-frontal suture

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For isolated blow-out fractures, the bone-plastic antrotomy method was utilized. This technique represents a modification of the transantral approach, allowing preservation of the bony flap due to its vascular supply from the periosteum and surrounding tissues.

The surgical technique involved the following steps: Under endotracheal anesthesia, an incision of the mucous membrane was made below the upper vestibular fold of the oral cavity, followed by the elevation of a mucoperiosteal flap. Tunnels were then formed along the frontal process and zygomatic-alveolar crest, and the anterior wall of the maxillary sinus was osteotomized, creating a bone-mucosal-periosteal flap. A Buyalsky spatula was introduced beneath the flap, and the bony segment was carefully fractured and displaced superiorly, providing access to the maxillary sinus cavity.

During surgery, the maxillary sinus was thoroughly debrided, with the removal of free bone fragments, altered mucosa, hematomas, and fatty tissue. After repositioning the fractured bone segments and orbital floor soft tissues, F-shaped titanium plates were used for fixation. In cases of extensive defects, individually contoured titanium meshes were applied.

Additionally, an artificial anastomosis with the inferior nasal meatus was created during surgery, with no nasal cavity packing required. The bone-periosteal-mucosal flap was repositioned and secured with Vicryl sutures, while the oral mucosa was closed using the same suture material.

All patients underwent ophthalmologic evaluation to assess visual function and potential complications. In addition to clinical and radiological assessments, all patients underwent photographic documentation before and after surgery, allowing for an objective evaluation of both aesthetic and functional outcomes.

Results and discussion. Analysis of clinical cases revealed a predominance of **isolated inferior orbital wall fractures (blow-out type)**, accounting for **57.14%** of cases, while **combined injuries involving the zygomatic-orbital complex** comprised **42.85%**. The majority of patients were **men (78.57%)**, which aligns with literature data indicating a greater predisposition of the male population to such injuries. The **average age** of the affected individuals was **37 years for men** and **31 years for women**.

A **detailed examination** of clinical data helped identify characteristic patterns and specific features of this pathology. In **63% of cases** involving isolated **inferior orbital wall fractures**, the trauma resulted from **blunt force impact**, such as a **punch, sports equipment injuries, or road traffic accidents**. In contrast, in **cases of combined zygomatic-orbital complex fractures**, **more than 70% of injuries** were caused by **high-intensity mechanical forces**, including **falls from height and blows with heavy objects**.

Surgical correction was performed using **modern techniques** aimed at **restoring the anatomical structure of the orbit and preventing long-term complications**. In **85% of cases**, **orbital floor reconstruction** was carried out using **titanium miniplates and individually contoured mesh implants**. The remaining **15% of cases** were treated with **autografts**, primarily **auricular cartilage and segments of the anterior wall of the maxillary sinus**, ensuring **optimal biocompatibility and mechanical strength** of the reconstructed structure.

The **functional recovery rates** were remarkably high. In **96% of cases**, **binocular vision was fully restored**, with no signs of persistent **diplopia**. **Mild residual symptoms**, such as **slight restriction of ocular motility** and **minor enophthalmos (up to 1 mm)**, were observed in **4% of patients**; however, these manifestations had no significant impact on the **overall quality of life**. The analysis demonstrated that the use of **high-porosity titanium mesh implants** significantly reduces the **risk of postoperative complications**, prevents **soft tissue adhesion to the implant**, and helps **maintain normal ocular motility**.

Particular attention was given to **postoperative pain management and rehabilitation timelines**. The use of **comprehensive anti-inflammatory and analgesic therapy**, including **long-acting glucocorticosteroids**, effectively reduced **pain levels** during the **first three days post-surgery** and shortened the **average hospital stay by 2.5 days** compared to conventional techniques.

In all **clinical cases**, **both functional and aesthetic deficits caused by the injury were completely eliminated**. No **postoperative complications** were recorded. Follow-up observations over a **6-month period** confirmed the **stability of the achieved results**, with **no late recurrences or complications**, highlighting the **high effectiveness of the proposed comprehensive approach** in the **treatment of inferior orbital wall fractures**.

Conclusions. The high effectiveness of the treatment, reflected in the elimination of diplopia, enophthalmos, and the absence of complications, can be attributed to several key factors:

1. Timely surgical intervention was performed within two weeks of trauma, which prevented the development of fibrotic changes and deformities that could complicate correction.

2. The use of titanium implants provided rigid fixation of the orbital floor, contributing to stable functional and aesthetic outcomes in the long term.

3. The transantral approach not only allowed for sanitation of the maxillary sinus, preventing the occurrence of post-traumatic sinusitis, but also minimized direct contact between the implant and orbital contents, thereby reducing the risk of infectious complications.

4. The bone-plastic antrotomy technique helped avoid defects in the anterior wall of the maxillary sinus, leading to a smoother postoperative recovery. Patients exhibited less soft tissue edema and an absence of transient hypoesthesia in the infraorbital region, which is commonly observed in standard antrotomy techniques.

Thus, the proposed surgical treatment strategy demonstrated high efficiency and safety, ensuring restoration of anatomical integrity and orbital function.

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