

The functional and aesthetic aspects of blow-out fracture treatment

Aspekty funkcjonalne i estetyczne leczenia urazów blow-out

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Abstract:

Introduction and aim of the study: Blow-out fractures of the orbit, most commonly involving the inferior wall, are severe facial injuries. The functional impairments (including diplopia and restricted ocular motility) and aesthetic deformities (such as facial asymmetry and enophthalmos) significantly affect the patient's overall health and quality of life. This paper aims to analyze the current knowledge regarding the diagnosis, treatment, and functional and aesthetic aspects of blow-out orbital fractures.

Current knowledge: Blow-out fractures are most often the result of blunt trauma, such as in traffic accidents, falls, or interpersonal violence. The injury leads to increased intra-orbital pressure and damage to the orbital structures. Diagnosis relies on imaging techniques, including computed tomography (CT) and magnetic resonance imaging (MRI), which allow for assessment of the extent of the damage. Treatment depends on the size

of the fracture and the presence of complications. In some cases, surgical intervention is necessary, which may include using bone grafts or implants to restore both function and aesthetics.

Conclusion: Early diagnosis and the application of appropriate treatment methods, including reconstructive surgery, are crucial for improving the functional and aesthetic aspects of patients. Endoscopic surgery for blow-out fractures demonstrates minimal invasiveness and better aesthetic outcomes, reducing the risk of complications and enhancing patients' quality of life.

Keywords: blow-out fracture, orbit, classification, diagnostics, treatment

Streszczenie:

Wprowadzenie i cel pracy: Złamania typu „blow-out” oczodołu, najczęściej obejmujące jego ścianę dolną, należą do ciężkich urazów twarzoczaszki. Zmiany czynnościowe z nimi związane (takie jak diplopia i ograniczenie ruchomości gałki ocznej) oraz zmiany estetyczne (np. asymetria twarzy i enoftalmos) mają istotny wpływ na zdrowie pacjenta. Celem niniejszej pracy jest analiza aktualnego stanu wiedzy dotyczącej diagnostyki, leczenia oraz aspektów czynnościowych i estetycznych złamań typu „blow-out” oczodołu.

Aktualny stan wiedzy: Złamania typu „blow-out” są najczęściej wynikiem tępego urazu, jak w wypadkach komunikacyjnych, upadkach czy przemocy interpersonalnej. Uraz prowadzi do wzrostu ciśnienia wewnątrzoczodołowego i uszkodzenia struktur oczodołu. Diagnostyka opiera się na technikach obrazowania, takich jak tomografia komputerowa (CT) i rezonans magnetyczny (MRI), które pozwalają na ocenę rozległości uszkodzeń. Postępowanie terapeutyczne jest uzależnione od rozległości złamania oraz występowania ewentualnych powikłań. W niektórych przypadkach konieczna jest interwencja chirurgiczna, obejmująca zastosowanie przeszczepów kostnych lub implantów w celu przywrócenia zarówno funkcji, jak i estetyki.

Wnioski: Wczesna diagnostyka i zastosowanie odpowiednich metod leczenia, w tym chirurgii rekonstrukcyjnej, są kluczowe dla poprawy aspektów czynnościowych i estetycznych u pacjentów. Endoskopowa chirurgia złamań typu „blow-out” wykazuje minimalną inwazyjność oraz lepsze efekty estetyczne, zmniejszając ryzyko powikłań i poprawiając jakość życia pacjentów.

Słowa kluczowe: złamanie blow-out, oczodół, klasyfikacja, diagnostyka, leczenie

Introduction

The orbit is a bony cavity in which the eyeball, nerves, blood vessels, intraocular muscles, and fat are located. The structure of the orbit can be divided into the roof, lateral and medial walls, and the floor. The roof of the orbit is composed of the frontal bone and the lesser wing of the sphenoid bone, the lateral wall is formed by the zygomatic bone and the greater wing of the sphenoid bone, the medial wall consists of the ethmoid, maxillary, and sphenoid bones, and the floor is formed by the maxillary, palatine, and zygomatic bones [1]. Blow-out fractures primarily occur in the orbit floor, which also forms the roof of the maxillary sinus [2].

A blow-out fracture results from blunt trauma, which can occur during traffic accidents, sports injuries (e.g., ball strikes), or other mechanical injuries. It is associated with force applied to the orbit, leading to an increase in intraorbital pressure and damage to the orbital walls [3]. The most common damage occurs to the inferior wall of the orbit, as it is the narrowest and weakest. One of the most frequent causes of a blow-out fracture is a “fist strike.” As a result of the injury, the eyeball is pushed backward into the narrower part of the orbit, causing a rapid increase in intraorbital pressure. This pressure is transferred to the orbital walls, leading to a fracture (Figure 1.) [2, 11]. This damage results in the extrusion of soft tissues, including the inferior rectus and inferior oblique muscles.

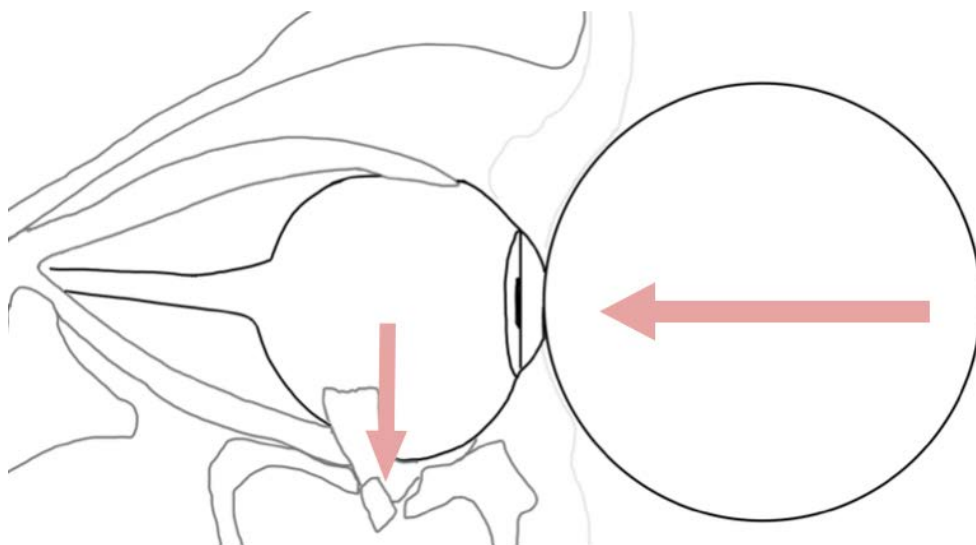


Figure 1. Schematic of the injury mechanism leading to a blow-out fracture of the orbit (own drawing).

Such fractures are considered to be among the most common facial injuries, accounting for 30–40% of all facial skeletal fractures. Isolated fractures of the orbital floor constitute 4% to 16% of these cases. The frequency of this injury is due to the anatomical structure of the orbital floor, which has a thickness of about 2 mm. This injury occurs more often in men, with a male-to-female ratio ranging from 2.5:1 to 4:1, peaking between the ages of 19 and 38. Among older individuals, the most common causes of such injuries are falls at home and episodes of fainting, while in younger individuals, the most frequent causes are interpersonal violence and sports accidents. Between 2006 and 2017, there was an increase in the incidence of orbital floor fractures, largely due to a rise in the number of traffic accidents [4, 25].

The diagnosis of orbital fractures largely relies on the clinical presentation, imaging studies, and collaboration among multiple specialists. Among the symptoms of a blow-out fracture, both functional and aesthetic changes are observed. Functional changes include diplopia, which occurs as a result of the entrapment of the ocular muscles (the inferior oblique and inferior rectus muscles) as well as connective tissue and fat at the site of the fracture [23]. There is a restriction in the mobility of the eyeball at the site of the injury due to the mechanical blockage of tissues and muscle damage. These injuries can also lead to aesthetic changes such as enophthalmos and facial asymmetry [10]. Facial deformity may also have psychological effects, which further supports the need for an interdisciplinary approach to treatment. Clinical data shows that enophthalmos appears several days after the injury. If surgical treatment is not performed, the enophthalmos worsens. Periorbital changes such as petechial hemorrhages of varying intensity, edema, and subcutaneous emphysema are noticeable. However, clinical symptoms can vary. Their occurrence depends on the extent of the damage and the time elapsed from the injury to the initiation of treatment [10, 17].

Orbital fractures can be classified based on size, location, injury mechanism, and the presence of associated injuries.

The Academy of Orthognathic and Maxillofacial Surgery (AOCMF) classification, developed by Smith and Regen, divides blow-out fractures into pure and impure, depending on whether the fracture involves only the orbital floor or also other structures, such as the zygomatic bone, and highlights differences in the mechanisms of injury. A pure blow-out fracture is an isolated fracture of the orbital floor with preservation of the orbital rim. It results from a moderate-force impact on the orbit. An impure blow-out fracture is accompanied by fractures of other facial structures and is often associated with high-energy trauma [19, 21].

Cole et al. developed a classification based on the size of the injury, which considers the fracture surface area. The fractures are categorized as small, medium, and large. This classification is useful for assessing surgical treatment and prognosis. Small fractures typically do not cause significant anatomical deformities. Medium fractures may require precise surgical treatment. Large fractures usually involve the entire orbital floor, which can lead to significant deformities and also require surgical intervention (Table 1) [9].

Table 1. Classification Based on Injury Size.

Fracture Type	Surface Area
Small fractures	< 2 cm ²
Medium fractures	2–2.5 cm ²
Large fractures	> 2.5 cm ²

In addition to the classification based on size, orbital fractures are also categorized according to the mechanism of injury, which differs from the force applied to the tissues and the extent of the damage. Among these, blunt trauma (blunt force trauma) is caused by a direct impact on the orbital region. The force applied to the tissues is typically moderate or large, leading to an increase in intraorbital pressure. These injuries are commonly caused by fist strikes, sports-related impacts, or traffic accidents. Blunt trauma is associated with isolated orbital fractures without damage to other structures [28, 29].

The classification also includes penetrating injuries caused by sharp forces, leading to extensive damage to multiple structures (muscles, fat tissue, and bone). These injuries require urgent surgical intervention to prevent further complications. Differentiation between these types of injuries plays a key role in diagnostic accuracy and treatment strategy, with significant implications for prognosis and the likelihood of complications [27, 30].

Takahashi et al. provided a detailed description of the classification of blow-out fractures, focusing on the location. They identified fractures of the inferior wall, which are the most common and occur due to its thin structure. A frequent complication of this fracture is the displacement of soft tissues into the maxillary sinus. Fractures of the medial wall may also occur, accompanied by the displacement of soft tissues into the ethmoid sinus. Such damage leads to restricted movement of the extraocular muscles and may result in orbital deformity or facial asymmetry. Knowledge of the location is crucial in the diagnostic and treatment process [20].

Diagnostics

Ophthalmic and otolaryngologic assessments are crucial. The ophthalmic examination includes checking the range of ocular movements, visual acuity, cranial nerve function, and the presence of symptoms such as diplopia, enophthalmos, or facial asymmetry [22]. The otolaryngologic examination evaluates the displacement of tissues toward the paranasal sinuses. Imaging studies play a very important role in the diagnosis, particularly computed tomography (CT), which is considered the gold standard for diagnosing blow-out fractures, and magnetic resonance imaging (MRI). Computed tomography (CT), especially in coronal projection, is a high-resolution imaging technique that allows precise visualization of orbital wall fractures, tissue displacement, and other bony injuries. It enables detailed surgical planning [24]. Computed tomography (CT) is also helpful in determining the extent of orbital volume increase, which helps predict the risk of enophthalmos (a volume increase of $>13\%$ is a risk indicator) [5]. Magnetic resonance imaging (MRI), though used less frequently, is particularly useful for assessing damage to the ocular muscles, cranial nerves, and orbital tissues. It is key for detecting inflammatory changes and intracranial injuries [7].

Specialized ophthalmic examinations include the Hess test, which is used to assess the function of the extraocular muscles and the extent of double vision. It involves projecting light points onto a grid and observing their divergence. The Hess chart, showing deviations from the norm, indicates muscle weakness, hyperactivity, or paralysis. The result helps determine which muscles require further diagnostics or treatment [6, 18].

Courtney et al. (2000) demonstrated the particular usefulness of this test in cases of persistent restriction of eye movement or muscle compression due to fractures, suggesting the need for further surgical intervention. The diagnostic value of the Hess test in assessing the range of functional disturbances following an orbital injury is estimated to be around 75% [6].

Treatment

Conservative treatment as an initial approach involves the administration of antibiotics and steroids to reduce the risk of infection and swelling that could lead to compression of the optic nerve. Nasal blowing is not recommended due to the risk of blowing sinus contents into the orbit. Most orbital fractures do not require surgical intervention and should be monitored for several days to weeks until the hematoma and swelling subside [17, 22].

Indications for surgical treatment include: diplopia with restricted upward gaze, a positive traction test on days 7-10 after the injury, radiological changes, enophthalmos greater than 2 mm, which presents an aesthetic issue, and large fractures involving at least half of the orbital floor. Surgical intervention should be performed within 2 weeks of the fracture to prevent the persistence of double vision and to improve aesthetic concerns such as enophthalmos [9, 10].

Surgical treatment typically involves an approach through the lower eyelid. The procedure includes placing a bone graft or implant to secure the orbital floor and prevent further tissue displacement into the fracture gap. Bone grafts are typically taken from the iliac crest or the frontal sinus wall [10, 26]. The goal of the procedure is to reconstruct the orbital floor. In classical surgical techniques, complications are more common, including facial asymmetry, which affects the patient's appearance, orbital tissue infection, implant displacement, damage to the lacrimal pump, and sensory disturbances in the area innervated by the infraorbital nerve [13].

Successful surgical repair of orbital trauma depends on the visualization of the injury. The use of an endoscopic approach offers visualization of the entire orbital floor, allowing the fracture to be treated without making an incision in the eyelid. Endoscopic treatment of blow-out fractures provides minimal invasiveness and precise restoration of the orbital anatomical structure. By making a small incision, this procedure minimizes the formation of visible scars and reduces the risk of infection [16]. The ability to directly view the inside of the orbit allows for accurate assessment of the damage, removal of bone fragments, and the implantation of materials to reconstruct the orbital floor [15]. Endoscopic surgery minimizes the risk of facial skin deformation and allows for more precise restoration of the orbital structure. It also shortens the duration of postoperative hospitalization. Zhang et al. highlight the importance of maintaining facial aesthetics, such as preserving the natural contours of the face and preventing visible scars, which is facilitated by endoscopic methods [8]. Rehabilitation is also essential, particularly in cases of fractures affecting ocular mobility [14].

Research shows that facial injuries, including blow-out fractures of the orbit, have significant psychological consequences, such as increased risk of anxiety, depression, and body image issues. Emotional support for patients through psychotherapy and reconstructive surgery is critical in the rehabilitation process. Early and appropriate psychological support is an essential component of treatment, influencing the improvement in the quality of life for patients following facial injuries [12].

Methods

This analysis focuses on scientific publications related to blow-out fractures of the orbit, with a concentration on the latest reports concerning the diagnosis and treatment of these injuries. The data sources include publications from peer-reviewed journals and official scientific databases. The following keywords were used: “blow-out fracture,” “orbital fracture,” “diagnosis of orbital fractures,” “treatment of orbital fractures,” “CT scan,” “MRI,” “orbital surgery,” “expansive fracture.” The bibliographies of the searched items and other sources were manually reviewed. The publications provide information on various diagnostic methods, their sensitivity, specificity, and application in clinical practice. The analysis evaluates how early detection of the condition impacts the effectiveness of treatment and the quality of life of patients.

Discussion

Blow-out fractures, especially those involving the orbital floor, are significant injuries that can lead to numerous complications, both functional and aesthetic. Analysis of results from various studies indicates that early diagnosis and the application of modern treatment methods are crucial in improving therapeutic outcomes. Research by Lee et al. demonstrated that early recognition of extraocular muscle damage and their release from entrapment due to the fracture can significantly improve eye function and reduce the risk of chronic issues, such as diplopia [3]. These findings align with previous studies by Courtney et al., which emphasize the importance of timely intervention in treating ocular motility problems to prevent functional disturbances from becoming permanent [6].

Regarding aesthetic treatment, Zhang et al. proved that the use of endoscopic surgery in blow-out fractures improves aesthetic results by minimizing scar visibility and accelerating recovery [8]. These findings are consistent with observations by AlSubaie et al., who noted that endoscopic approaches also reduce the risk of complications and shorten hospitalization time, which is crucial for the overall improvement in patients’ quality of life [9].

Modern imaging diagnostics, including computed tomography (CT) and magnetic resonance imaging (MRI), are helpful tools in treatment planning for orbital fractures. Schouman et al. showed that the use of advanced diagnostic technologies allows for the precise determination of soft and hard tissue damage, which is critical in deciding on the next steps in treatment [5]. These studies confirm earlier work indicating the role of accurate diagnostics in preventing complications and improving treatment outcomes, both functional and aesthetic.

Reconstructive surgery, particularly with the use of bone grafts or implants, is essential in cases of more severe orbital fractures. Research by Cole et al. highlighted that such procedures are crucial for restoring the anatomical structure of the face and preventing further complications [7]. The minimally invasive approach, especially with the use of endoscopy, shows clear benefits in reducing infection risks and improving aesthetic outcomes, as confirmed by Zhang et al. [8].

In the future, the further development of diagnostic techniques, such as artificial intelligence in image analysis, may enable even more precise and rapid identification of blow-out fractures, allowing for more personalized treatment. At the same time, advances in surgical methods, such as robotics and advanced implants, may significantly improve treatment outcomes by minimizing complications and shortening recovery times.

Conclusions

Blow-out fractures are severe facial injuries that require rapid diagnosis and a multidisciplinary approach to treatment. Modern diagnostic technologies, such as computed tomography (CT) and magnetic resonance imaging (MRI), as well as advanced surgical techniques, including endoscopic surgery, enable effective management of these injuries, improving both functional and aesthetic outcomes. Early diagnosis and appropriate intervention are crucial in preventing long-term complications and improving patients' quality of life. Surgical treatment, particularly endoscopic methods, offers the potential to enhance both functional and aesthetic aspects of the patient's face. In the future, further development of imaging techniques and minimally invasive surgery will significantly impact the improvement of treatment outcomes and reduction of complications.

Abbreviations:

AOCMF: Academy of Orthognathic and Maxillofacial Surgery MRI: Magnetic Resonance Imaging CT: Computed Tomography

Disclosure

Authors contribution: Damian Ujazda, Jan Wójtowicz, Oliwia Dominiak, Weronika Głąb, Aleksandra Komoń, Artur Grobelny

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All authors have read and agreed with the published version of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

Funding Statement: No external funding was received to perform this review.

Board Statement: Not applicable – this review included an analysis of the available literature.

Statement of Informed Consent: Not applicable.

References:

1. Drake R.L., Vogl A.W., Mitchell A.W.M.: Anatomia Gray – Podręcznik dla studentów. T. 1-3. Wyd. IV. Wydawnictwo Edra Urban & Partner. Wrocław 2020.
2. Arkuszewski P, Arkuszewski P, Zielińska M, Meissner E. Medicolegal assessment in cases of zygomatic-maxillo-orbital fractures and isolated orbital floor fractures in criminal cases. *Archiwum Medycyny Sądowej i Kryminologii/Archives of Forensic Medicine and Criminology*. 2019;1-39. Doi:10.5114/amsik.2019.89234.
3. Lee, Da Woon MD; Ryu, Heongrae MD; Kim, Jun Hyuk MD, PhD; Choi, Hwan Jun MD, PhD. Pathophysiologic Review of Blow-Out Fracture and Blow-Out Fracture Extended to Subarachnoid Space Due to Air Gun Injury. *Journal of Craniofacial Surgery*, 2022; 33(1):p 240-242 Doi: 10.1097/SCS.00000000000008020
4. Troise, S., Committeri, U., Barone, S., Gentile, D., Arena, A., Salzano, G., i in. Epidemiological analysis of patients with isolated blowout fractures of orbital floor: Correlation between demographic characteristics and fracture area. *Journal of Cranio-Maxillofacial Surgery*, 2024; 52(3), 334-339. Doi: 10.1016/j.jcms.2023.10.007
5. Schouman, T., Courvoisier, D. S., Van Issum, C., Terzic, A., Scolozzi, P. Can systematic computed tomographic scan assessment predict treatment decisions in pure orbital floor blowout fractures? *Journal of oral and maxillofacial surgery*, 2012; 70(7), 1627-1632. Doi: 10.1016/j.joms.2012.03.006
6. Courtney, D. J., Thomas, S., & Whitfield, P. H. Isolated orbital blowout fractures: survey and review. *British Journal of Oral and Maxillofacial Surgery*, 2000; 38(5), 496-503. Doi: 10.1054/bjom.2000.0500.
7. AlSubaie, M. F., Al-Sharydah, A. M., Nassim, H. M., & Alhawsawi, A. Orbital Floor Blowout Fracture Reconstruction Using Moldable Polymethyl Methacrylate: A Report of Two Cases and Their Imaging Findings. *Open Access Emergency Medicine*, 2022; 14, 223–232. Doi.org/10.2147/OAEM.S359173

8. Zhang, S., Li, Y. & Fan, X. Application of endoscopic techniques in orbital blowout fractures. *Front. Med.* 2013; 7, 328–332. Doi.org/10.1007/s11684-013-0271-5
9. Cole, Patrick M.D.; Boyd, Vincent M.D.; Banerji, Soumo B.S.; Hollier, Larry H. Jr M.D.. *Comprehensive Management of Orbital Fractures. Plastic and Reconstructive Surgery.* 2007; 120(7):p 57S-63S, Doi: 10.1097/01.prs.0000260752.20481.b4
10. B. Bowling. *Okulistyka kliniczna Kanski. Wyd. VIII. Wydawnictwo Edra Urban & Partner. Wrocław* 2021.
11. Wang JM, Fries FN, Hendrix P, Brinker T, Loukas M, Tubbs RS. Orbital Blowout Fracture with Complete Dislocation of the Globe into the Maxillary Sinus. *Cureus.* 2017;9(9):e1728. Doi:10.7759/cureus.1728.
12. McMinn KR, Bennett M, Powers MB, Foreman ML, Reddy LV, Warren AM. Craniofacial Trauma Is Associated With Significant Psychosocial Morbidity 1 Year Post-Injury. *J Oral Maxillofac Surg.* 2018;76(12):2610.e1-2610.e8. Doi:10.1016/j.joms.2018.08.006.
13. Lima, L. B., de Miranda, R. B. M., Furtado, L. M., Rocha, F. S., da Silva, M. C. P., & Silva, C. J. Reconstruction of the orbital floor for treatment of a pure blowout fracture. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*, 2015; 56(2), 122-126.
14. Skorek, A., Stankiewicz, C., Babiński, D., Ostrowska, A., & Stoduski, D. Urazy oczodołu. *Otolaryngologia Polska*, 2007; 61(4), 409-415.
15. Strong EB. Endoscopic repair of orbital blow-out fractures. *Facial Plast Surg.* 2004 ;20(3):223-30. Doi:10.1055/s-2004-861778.
16. Hong, Suji MD; Kim, Joohyun MD; Baek, Sehyun MD, PhD. Blowout Fracture Assessment Based on Computed Tomography and Endoscopy: The Effectiveness of Endoscopy for Fracture Repair. *Journal of Craniofacial Surgery.* 2022; 33(4):p 1008-1012, Doi:10.1097/SCS.00000000000008170
17. Basic and Clinical Science Course. *Oczodoł, powieki i układ łzowy (BCSC 7).* Wydawca Emilia. Wrocław 2005
18. Park J, Jo S, Choi HY. Clinical Results According to Inferior Oblique Manipulation in Patients with Inferomedial Blowout Fracture Involving the Orbital Strut. *Clin Ophthalmol.* 2022;16:4263-4272. Doi: 10.2147/OPHTH.S394722
19. Kunz C, Audigé L, Cornelius C-P, Buitrago-Téllez CH, Rudderman R, Prein J. The Comprehensive AOCMF Classification System: Orbital Fractures – Level 3 Tutorial. *Craniofacial Trauma & Reconstruction.* 2014;7(1_suppl):92-102. Doi:10.1055/s-0034-1389562
20. Takahashi, Yasuhiro M.D., Ph.D.; Nakakura, Shunsuke M.D., Ph.D.; Sabundayo, Maria Suzanne M.D.; Kitaguchi, Yoshiyuki M.D., Ph.D.; Miyazaki, Hidetaka D.D.S., Ph.D.; Mito, Hidenori M.D.; Kakizaki, Hirohiko M.D., Ph.D.. Differences in Common Orbital Blowout Fracture Sites by Age. *Plastic and Reconstructive Surgery.* 2018; 141(6):p 893e-901e, Doi:10.1097/PRS.00000000000004397
21. Smith, B., & Regan Jr, W. F. Blow-out fracture of the orbit: mechanism and correction of internal orbital fracture. *American journal of ophthalmology*, 1957; 44(6), 733-739. Doi.org/10.1016/0002-9394(76)90774-1
22. Boyette, J. R., Pemberton, J. D., & Bonilla-Velez, J. Management of orbital fractures: challenges and solutions. *Clinical Ophthalmology*, 2015; 9, 2127–2137. Doi.org/10.2147/OPHTH.S80463
23. Józefowicz-Korczyńska, M., Starska, K., & Miśkiewicz, B. Objawy oczne i oczodołowe po urazach nosa i zatok przynosowych. *Otaryngologia*, 2011; 10(4).

24. Schouman, T., Courvoisier, D. S., Van Issum, C., Terzic, A., & Scolozzi, P. Can systematic computed tomographic scan assessment predict treatment decisions in pure orbital floor blowout fractures? *Journal of oral and maxillofacial surgery*. 2012; 70(7), 1627-1632 Doi.org/10.1016/j.joms.2012.03.006
25. Van Hout, W. M., Van Cann, E. M., Abbink, J. H., & Koole, R. An epidemiological study of maxillofacial fractures requiring surgical treatment at a tertiary trauma center between 2005 and 2010. *British journal of oral and maxillofacial surgery*. 2013; 51(5), 416-420. Doi.org/10.1016/j.bjoms.2012.11.002
26. Piombino, P., Troise, S., Maglito, F. et al. Management of Orbital Floor Fractures: Our Experience in 10 Years. *Indian J Otolaryngol Head Neck Surg*. 2022; 74, 547–554. Doi.org/10.1007/s12070-022-03127-9
27. Citation Neskromna-Jędrzejczak A, Bogusiak K, Przygoński A, Antoszewski B. Uraz penetrujący twarzy i kości części twarzowej czaszki – opis sześciu przypadków. *Pol Przegl Chir*. 2017;89(1):50-60. Doi.org/10.5604/01.3001.0009.6004.
28. Khojastepour, L., Moannaei, M., Eftekharian, H. R., Khaghaninejad, M. S., Mahjoori-Ghasrodashti, M., Tavanafar, S. Prevalence and severity of orbital blowout fractures. *British Journal of Oral and Maxillofacial Surgery*. 2020; 58(9),e93-e97 Doi.org/10.1016/j.bjoms.2020.07.001
29. Ali, D., Najim, O., & Wojciechowski, A. . Radiological Insights of a Complex Orbital Blow-Out Fracture. *Cureus*. 2024; 16(11). Doi:10.7759/cureus.74804
30. Noh, H., Chung, J.K., Woo, K.I. et al. Occurrence of ocular injury and orbital fracture in orbital blunt trauma patients at tertiary care center emergency room. *Graefes Arch Clin Exp Ophthalmol*. 2021;259, 165–171. Doi.org/10.1007/s00417-020-04786-6