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STATE OF THE ORBITAL FLOOR IN A ZYGOMATICO-ORBITAL COMPLEX FRACTURE

Master's thesis

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РЕФЕРАТ

Нарушение целостности стенок орбиты и смещение отломков может приводить к функционально-эстетическим нарушениям даже после репозиции скуловой кости. Своевременная диагностика наличия перелома стенки орбиты при травмах средней зоны лица позволяет выбрать верную тактику хирургического лечения пациентов. Основным методом определения наличия перелома и степени смещения отломков нижней стенки орбиты остается рентгенологический метод. Применение для диагностики различных видов компьютерной томографии позволяет достоверно определить наличие повреждений стенок орбиты.

Целью исследования было обосновать применение КЛКТ для диагностики переломов скуло-орбитального комплекса и провести сравнительный анализ пространственного положения нижней стенки орбиты в послеоперационном периоде как критерия эффективности хирургического лечения при переломе скуло-орбитального комплекса.

Объектом исследования были пациенты (30 пациентов) с переломами скуло-орбитального комплекса, которые находились на лечении 11 ГКБ г. Минска за 2015-2017 годы. Проведено изучение данных историй болезни и результатов до- и послеоперационного рентгенологического обследования.

В результате исследования выявлено, что метод конусно-лучевой компьютерной томографии может быть использован для оценки состояния нижней стенки орбиты при травмах скуло-орбиталього комплекса. Использования для этой цели конусно-лучевая компьютерная томография позволяет качественно оценить состояния отломков нижней стенки орбиты и характеризовать результаты оперативного лечения переломов скуло-орбитального комплекса.

РЭФЕРАТ

Парушэнне цэласнасці сценак арбіты і зрушэнне отломков можа прыводзіць да функцыянальна-эстэтычным парушэнняў нават пасля рэпазіцыі скуловой косткі. Своечасовая дыягностыка наяўнасці перелома сценкі арбіты пры траўмах соедней зоны асобы дазваляе выбраць верную тактыку хірургічнага лячэння пацыентаў. Асноўным метадам вызначэння наяўнасці пераломy і ступені зрушэння отломков ніжняй сценкі арбіты застаецца рэнтгеналагічны метад. Прымяненне для дыягнастуеццa розных відаў кампутарнай тамаграфіі дазваляе дакладна вызначыць наяўнасць пашкоджанняў сценак арбіты.

Мэтай даследавання было абгрунтаваць прымяненне КЛКТ для дыягностыкі пераломаў скуло-арбітальнага комплексу і правесці параўнальны аналіз прасторавага становішча ніжняй сценкі арбіты ў пасляаперацыйным перыядзе як крытэрыю эфектыўнасці хірургічнага лячэння пры пераломе скуло-арбітальнага комплексу.

Аб'ектам даследавання былі пацыенты (30 пацыентаў) з пераломамі скуло-арбітальнага комплексу, якія знаходзіліся на лячэнні 11 ГКБ г. Мінска за 2015-2017 гады. Праведзена вывучэнне дадзеных гісторый хваробы і вынікаў да- і пасляаперацыйнага рэнтгеналагічнага абследавання.

У выніку даследавання выяўлена, што метад КЛКТ можа быць выкарыстаны для ацэнкі стану ніжняй сценкі арбіты пры траўмах скуло-арбітальнага комплексу. Выкарыстання для гэтай мэты КЛКТ дазваляе якасна ацаніць стану отломков ніжняй сетнки арбіты і характарызаваць вынікі лячэння пераломаў скуло-арбітальнага комплексу.

ABSTRACT

Violation of the integrity of the walls of the orbit and displacement of the fragments may lead to functional and aesthetic violations even after repositioning the zygomatic bone. Timely diagnosis of the presence of a fracture of the orbital wall in injuries of the joint zone of the face allows you to choose the right tactics of surgical treatment of patients. The main method for determining the presence of a fracture and the degree of displacement of the fragments of the lower wall of the orbit remains the x-ray method. The use of different types of computer tomography for diagnosis allows to determine reliably the presence of damage to the walls of the orbit.

The aim of the study was to justify the use of CBCT for the diagnosis of fractures of the zygoma-orbital complex and comparative analysis of the spatial position of the lower wall of the orbit in the postoperative period as a criterion of the effectiveness of surgical treatment for fracture of zygoma-orbital complex.

The object of the study were patients (30 patients) with fractures of the orbital complex, who were treated with 11 GKB in Minsk for 2015-2017 years. The study of these medical records and the results of pre- and postoperative x-ray examination.

The study revealed that the CBCT method can be used to assess the state of the lower wall of the orbit in injuries of the orbital complex. The use of CBCT for this purpose makes it possible to qualitatively assess the state of the fragments of the lower reticulum of the orbit and characterize the results of the operative treatment of fractures of the zygoma-orbital complex.

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LIST OF CONVENTIONS

RTA – Road Traffic Accident

CBCT – Cone Beam Computed Tomography

CT – Computed Tomography

MSCT – Multispiral Computer Tomography

ZOC – Zygomatico-Orbital Complex

U/S – Ultrasound Investigation

CCT – Cranio-Cerebral Trauma

3D – three dimensional

INTRODUCTION

The frequency of damage to facial bones remains at a high level and has a tendency to increase in recent years (A. S. Samykin, 2014; D. Yu. Khristoforando, 2011; R. B. A. Ykeda, 2012). In the specialist literature, when establishing bone fractures of the midface area, the following terminology is used: fractures of the zygomatic bone, zygomatic complex, zygomatico-orbital complex(ZOC), zygomaticomaxillary complex(ZMC), zygomatico-orbital-maxillary complex (A. Tadj, 2003; L. N. Gandi, 2012). Significant difficulties are presented by the determination of the type of damage to the zygoma and related anatomical structures due to various approaches in interpreting damages to midface bones and orbital walls. Differential diagnosis and treatment approach for fractures of the zygomatic bone, the zygomatico-orbital and zygomaticomaxillary complexes was determined by Pavlov O. M. [34]. In practice, in fractures of the zygomatic bone there is a fracture of orbital walls. This is due to the anatomical structure of the midface bones, where the body and processes of the zygomatic bone form part of the orbital floor and lateral walls. Accordingly, the solution of continuity of the zygomatic bone and its connection with other bones of the midface area: upper jaw, frontal, temporal and main bones.

However, in our study we are talking about the state of the orbital floor in a fracture of the ZOC. The prevalence of zygomatic fractures is high. These damages place third among fractures of the facial skeleton after fractures of the nose and lower jaw (V. S. Kunitsky, 2010; S. A. Semenov, 2012; K. Hwang, 2010), and according to the prevalence among bone fractures of the midface area, zygomatic bone fractures place second (A. Tadj, 2003). In the presence of a craniofacial injury, fractures of the zygomatic bone are the most common damaged bone of a face, while fractures of the zygomatic bone can be either isolated or combined with fractures of other bones of the facial skull.

Damage to the upper jaw, zygomatic bone, orbit is often associated with an accident and can be a component of both combined trauma and polytrauma (M. Rana, 2012). Accidents are the most common cause of craniocerebral injury. It was noted that severe damage to the facial skull in 35-40% of cases is associated with life-threatening intracranial hematomas or brain injuries (S. E. Connor, 2007). Outdoor activities and fights often lead to bone damages. The prevalence of accidents or attacks depends on different countries and their development characteristics (Shenoi S. R., 2012; K. H. Lee, 2007). Criminal injuries resulting from attacks, as well as home accidents, are said to be leading factors in damages of facial bones in developed countries (K. Hwang, 2010; V. Bhatt, 2012). So, in Europe and North America, criminal injuries and injuries sustained as a result of playing sports prevail over injuries resulting from road accidents. RTAs can make a significant contribution to mortality, so in Iran, injuries from RTAs place second in the overall mortality structure (A. H. Mesgarzadeh, 2011).

Bone fractures of the midface area, where the zygomatic bone is damaged, are of several types: fractures of the zygomatic bone, fractures of the zygomatico-orbital complex(ZOC), fractures of the zygomaticomaxillary complex(ZMC) (M. Rana, 2012). But in this case, they refer to fractures of the zygomatico-orbital complex(ZOC) and the state of the orbital floor in a fracture of the zygomatico-orbital complex(ZOC). A feature of midface injuries is that blows to the zygomatic bone usually lead to injuries in counterforces and rarely to fractures of the zygomatic bone itself. Researchers point to a frequent combination of a craniofacial injury with brain damage and CCT (D. Yu. Khristoforando, 2011). MSCT in a craniomaxillofacial trauma allows to accurately and quickly make a diagnosis, and reduces the total time of research (A. Z. Shalumov, 2009). But the presence of unstable hemodynamics, ongoing bleeding, respiratory failure may require intubation, mechanical ventilation, thoracostomy, arrest of heavy bleeding before performing MSCT (F. A. Sharifullin, 2010).

Using 3D modeling of results when carrying out MSCT allows not only to simply imagine the nature and scope of surgical procedures but also to facilitate the preparation for the surgical treatment stage.

For correct and timely diagnosis, it is necessary not only to conduct a clinical study, but also anatomically soundly divide the damage to the zygomatic bone into fractures of the zygomatic bone only, fractures that cause damage to the bones and soft tissue contents of the orbit, fractures, where the upper jaw is damaged. Damage to the maxillary sinus walls is observed in all bone fractures of the midface area. Fractures of the maxillary sinus walls lead to hemorrhages in the mucous membrane of the maxillary sinus, which, in turn, is a substrate for the development of post-traumatic sinusitis.

Incomplete or untimely diagnosis of injuries of the midface area bones leads to incomplete or untimely treatment, which causes complications and deformations of the facial skeleton.

It is necessary to provide clear rationale for the choice of mandatory methods for examining patients with fractures of the zygomatico-orbital complex(ZOC) in order to define the state of the orbital floor in a fracture of the zygomatico-orbital complex(ZOC). It is necessary to compare the capabilities of radiological methods for this type of damage to facilitate the clinical application of modern diagnostic methods.

To treat fractures of the zygomatico-orbital complex(ZOC), open and closed reduction methods are used. Often in the treatment of this group of injuries conflicting recommendations are given, which may be due to a different understanding of the anatomy of fractures and confusion in terms. The use of closed reduction methods is quite common in the treatment of fractures of the zygomatico-orbital complex(ZOC). For each country, certain methods of closed reduction are preferred, which are often historical in nature. So, in the UK and Australia, the most common is the temporal access reduction by Gillies (M. Rana, 2012), but the reduction by Limberg's hook is the most common in the CIS countries (Sh. A. Boymuradov, 2009). Closed reduction methods are not always simple, and the subsequent fixation of bone fragments is stable. To achieve predictable postoperative stability, open reduction methods with internal fixation(ORIF) are the best option. An open reduction begins with a reduction of the zygomatic bone body itself to the anatomically correct position, which is the basis for correct rigid fixation. It is essential not only to stably fix bone fragments, but also to restore the volume of the maxillary sinus, bone borders of the sinus walls, to eliminate the prolapse of soft tissues into the maxillary sinus cavity. Various methods are proposed for replacing bone defects in the walls of the maxillary sinus: from replanting their own bone fragments to finding materials for implantation that can eliminate existing bone defects. As materials for implantation, it is proposed to use hyper-extensible mesh titanium, implants based on porous polyethylene (K. Hwang, 2010; Chudakov O. P., Xie Xuykai, 2018).

A rather high percentage of the presence of post-traumatic deformations of the midface area (3-4% of the total number) is described in the literature (Pavlov O. M., 2017), which in the best way possible suggests that it is necessary to conduct high-quality modern diagnostics of this group of patients, but not to finish the radiation examination only by standardized roentgenography. The presence of an inflammatory process in the maxillary sinus significantly slows down the healing time of fractures of the ZOC.

Orbital fractures may seriously damage the infraorbital nerve(ION), which results in the patient's suffering from impaired paresthesia. It is difficult for a surgeon to free and secure the captured lower orbital nerve by reconstructing the orbital floor, for example, a fracture of the orbital floor with the captured infraorbital nerve(ION) during nerve decompression and ensuring its recovery (Rao, A. Y. N. et al., 2017). This is followed by an acute loss of sensory function of the infraorbital nerve(ION), which may be associated with compression, edema, ischemia, or contusion/neurotmesis [41]. Patients with paresthesia in the lower eyelid, nasal vestibule, and upper lip require careful examination. The incidence of long-term sensorineural disorders varies from 10 to 50% in various studies. The most common cause of such a neurological disorder is associated with nerve damage by fracture segments that have been reduced or improperly corrected [41].

GENERAL CHARACTERISTIC OF WORK

Rationale

The research rationale is based on the presence of severe complications associated with visual impairment, diplopia, and enophthalmos. These are the main consequences of a fracture of the orbital floor with damages to the zygomatico-orbital complex(ZOC), which can lead to functional visual impairment and facial appearance impairment. In maxillofacial surgery, attention is not always paid to the state of fragments of the orbital floor, which ensures the anatomical position of the eyeball. Timely and accurate diagnosis of the state of the orbital floor is crucial when deciding on the treatment of fractures of the orbital floor and is based on the clinical picture, ophthalmological examination and CT. In the Republic of Belarus, there is currently no comprehensive approach to the diagnosis and subsequent reconstruction of the orbital floor in zygomatico-orbital complex(ZOC) fractures. The treatment of isolated fractures of the orbital floor is provided by ophthalmologists. Whereas in damages to the ZOC, the diagnosis and treatment are carried out by maxillofacial surgeons. In the specialist literature, there is no convincing data on the study of the state of the orbital walls in fractures of the ZOC in the Republic of Belarus, as well as studies of the volumes of the orbit and maxillary sinus after injuries and the treatment of fractures of the ZOC. Given the literature data, confirming the need to analyze the state of the orbital walls in fractures of the ZOC, as a factor determining the development of severe functional and aesthetic consequences(diplopia, enophthalmos), the research topic is relevant and timely.

Object and subject of research

The object of research was 30 patients with injuries of the zygomatico-orbital complex(ZOC) who were treated in the Department of Maxillofacial Surgery of a healthcare institution in the 11th City Clinical Hospital in Minsk in the period 2015-2017 years. The subject of the research was medical history data and radiodiagnosis data(namely CBCT), patient data obtained before and after reducing the ZOC.

Purpose and Objectives of the Research

The purpose of the research is to use CBCT to diagnose fractures of the orbital floor with damages to the zygomatico-orbital complex(ZOC) and to evaluate the state of the orbital floor.

Objectives of the Research:

1. To provide the rationale for the use of cone beam computed tomography(CBCT) in the diagnosis of a fracture of the orbital wall with damages to the zygomatico-orbital complex(ZOC).

2. To determine the conditions of use of cone beam computed tomography(CBCT) in zygomatico-orbital complex(ZOC) fractures.

3. To determine the linear dimensions of the orbit to assess the state of the orbital floor in a zygomatico-orbital complex(ZOC) fracture.

4. To carry out a comparative analysis of the spatial position of the orbital floor in the postoperative period as a surgical treatment efficacy endpoint in a zygomatico-orbital complex(ZOC) fracture.

Provisions for Defence

1. Cone beam computed tomography(CBCT) is a reliable radiological method, which allows determining the presence of a fracture and the degree of dislocation of orbital floor fragments in fractures of the zygomatico-orbital complex(ZOC).

2. The effectiveness of cone beam computed tomography(CBCT) for the diagnosis of traumatic injuries of the zygomatico-orbital complex(ZOC) depends on the technical characteristics of the device and software.

3. Interpretation of cone beam computed tomography(CBCT) data in the examination of the orbital floor allows assessing the degree of dislocation of fragments.

4. After reducing the zygomatico-orbital complex(ZOC) without reconstructing the orbital floor, its spatial position is preserved.

Structure and scope of the thesis

The thesis consists of a table of contents, a list of symbols, an introduction, a general characteristic of the work, 3 chapters, a conclusion, references. The total number of pages is 81.

CHAPTER 1
REVIEW OF LITERATURE

The need for a detailed diagnosis and determination of indications for choosing a method to treat fractures of the ZOC and the need to restore or reconstruct the orbital floor is due to a wide range of complications and consequences of such injuries. In our opinion, the main complications and consequences of fractures of the ZOC are:

A) ***surgical complications:***

1) consequences associated with a change in the volume of the orbit [16], [37], [31], [33], [9], [3], [35], [48];

2) inadequate restoration of the orbital floor and inadequate restoration of the lateral orbit [26];

3) facial asymmetry [22], [58], [49], [9] and consequences associated with bone remodeling [37];

4) diplopia and enophthalmos [20], [7], [39], [53], [26], [59], [8], [14], [21], [58], [1], [19];

5) secondary deformations of the orbital floor and the need to replace the implant [2], [25], [10], [11];

6) emphysema [44] and loss of sensation of the infraorbital nerve(ION) [41];

7) a change in visual acuity, including its loss [13];

B) functional consequences, including concomitant damage to the orbit with ophthalmic disorders, facial hypesthesia, and trismus, and are often associated with concomitant injuries of other parts of the craniofacial skeleton, brain or spine [56].

C) indirect consequences, to which we refer the influence of surgical time on postoperative ocular motility [24]; and postoperative imaging (revision of surgical intervention) [54].

To determine the nature, location and degree of displacement of bone fragments of the orbital floor and other walls of the orbit, the symmetry of the midface lines in fractures of the zygomatico-orbital complex(ZOC), various methods are used that, in the authors' opinion, provide an accurate interpretation of clinical data and the results of radiation diagnostics.

Conventionally, we can subdivide methods for assessing the state of damaged structures of the zygomatico-orbital complex(ZOC) and the orbital floor into the following:

1. clinical;
2. radiodiagnosis;
3. prototyping;
4. intraoperative imaging and navigation.

Clinical methods for assessing post-traumatic changes in the ZOC are widely used in determining the postoperative outcome. For example, the clinical determination of the three-dimensional(3D) symmetry of the zygomatico-orbital complex(ZOC) is possible with the use of the damaged surface mirroring and matching method (Jean-Pierre T. F. Ho et al., Blumer et al., 2016). The developed method, in authors' opinion _Jean-Pierre T. F. Ho et al. [32], Blumer et al. [25], is an accurate tool for assessing the symmetry of the ZOC, which can be used to diagnose and evaluate the quality of treatment.

Symmetry assessment using a portable mirror stand(a device with a mirror stand with a software method) in the postoperative period in patients with a zygomatic bone fracture was performed by Syarif, A. N. [50]. However, in the absence of a standard and reliable method available for assessing the status of postoperative patients, they often rely on photographs and subjective assessments (Syarif, A. N. et al., 2017). Portable Mirror Stand(MiRS), according to Syarif, A. N. et al. [50], is a new method of standardizing photography and was developed at the Cipto Mangunkusumo Hospital (USA, Harvard) in the craniofacial cleft department. This device with image analysis software is a new method for estimating results after open reduction and internal fixation(ORIF) of zygomatic fractures. The portable mirror stand(MiRS) was a device with such image analysis software (Image J 1.46), which may be useful in assessing symmetry in postoperative patients with a fractured cheekbone (Syarif, A. N. et al., 2017).

Currently, the effect of visual electrophysiology and field of view examination in patients with orbital blowout fracture(BOF) is rarely studied. Shao-Rui Liu et al. [13], conducted an examination of visual function in patients with an orbital fracture by visual electrophysiology and examined the field of view in the diagnosis of eye contusion. A comprehensive assessment of visual function in patients with an orbital fracture was made by visual electrophysiology and field of vision examinations [13]. Currently, the effect of visual electrophysiology along with field of view examination in patients with orbital blowout fracture(BOF) is rarely studied. So, (Shao-Rui Liu et al., 2018), the importance of visual electrophysiology and field of view examination in the diagnosis of eye contusion is studied. Visual acuity in orbital fractures is significantly reduced compared to visual acuity in intact eyes (Shao-Rui Liu et al., 2018). A fracture of the orbital floor can lead to damage to the optic nerve, and may also be associated with a decrease in the macula function. A combined analysis of visual electrophysiology along with field of view examination is useful for early diagnosis of eye injury and can improve a positive indicator in clinical practice.

Exophthalmometry is a measurement of the degree of forward displacement of the eye. It is made using a special device called "exophthalmometer". A Hertel mirror exophthalmometer is most commonly used. The medical term "exophthalmometry" is used to refer to a diagnostic technique that allows determining the degree of protrusion of the eyeball from the eye socket in various diseases. A special device, an exophthalmometer, is used in the process, which allows one to assess whether the patient has protrusion(exophthalmos) or retraction(enophthalmos) of the eyeball with respect to normal limitations [59], [39], [1]. The degree of enophthalmos can be determined using a Hertel exophthalmometer (Swati Tiwari et al., 2017).

The measurement of the eyeball position in compound orbital fractures (type II) and the assessment of the patient's condition using a modified exophthalmometer or digital technology or a device, the position of the eyeball was assessed using either a Hertel exophthalmometer or a modified device with fixation of the auditory canal in 27 patients with compound fractures of the orbit (18 fractures of the zygomaticomaxillary complex(ZMC) and 9 fractures of Le Fort). Although 94% of patients with fractures of the ZOC had relative exophthalmos on the side of the fracture or no differences between the eyes according to Hertel exophthalmometry, more than 30% of the same patients showed relative enophthalmos when measured using an auditory canal fixation device. In three of four patients undergoing surgical orbital floor repair, modified exophthalmometry showed exophthalmos greater than or equal to 2 mm after surgery on the fracture side. The relatively low incidence of enophthalmos in fractures of the zygomaticomaxillary complex(ZMC) indicates the need for selective repair of the orbital floor [59].

The measurement of the eyeball position in compound orbital fractures and the assessment of the patient's condition using a modified exophthalmometer are associated with the fact that a uniform examination of the orbital floor cannot lead to objective results. Multiple comminuted facial fractures (Le Fort II and III) show a large variability in the position of the eyeball and a high frequency (90%) of enophthalmos, which indicates the need for early repair of the orbit in these patients. Exophthalmometry with fixation of the auditory canal can provide significant information on the position of the eyeball in patients with fractures of the orbital facial region, in which methods based on the orbital ring are excluded (Yeatts R. Patrick, 1992).

David Carpenter, Ronnie Shammas, et al., addressed the issue of whether postoperative imaging can reveal the consequences of surgery [54].

The most common methods for diagnosing fractures of the zygomatico-orbital complex(ZOC) and the orbital floor are ***radiological methods***.

According to Sandoval, H. M. et al. [44], a radiographic examination of the facial skull in a half-axial projection allows assessing the state of the orbital floor, prolapse of the orbit contents and the air-liquid ratio in the maxillary sinus [44]. According to Sandoval, H. M. et al. [44], significantly more complete information about the severity of damage can be received by using computed tomography(CT).

CT makes it possible to assess the condition of both osseous and soft tissue structures. Today, according to Sandoval, H. M. et al., CT remains the main diagnostic method of choice for orbital injury [44].

According to Sandoval, H. M. et al. [44], the leading instrumental method for examining the state of the orbit is radiodiagnosis because numerous and laborious X-ray examinations do not have the proper informativeness [44], often misleading the doctor and significantly delaying the diagnosis [44]. The probability of error (a fracture missed during radiography diagnosed with subsequent coronary computed tomography), according to Sandoval, H. M. et al. [44], is 10 – 13% for the floor and 20 – 30% for the fractions of the internal wall [44]. Therefore, at this point, radiography in the scope of survey studies of the skull and the orbit is used as a screening method only at the stage of admission of the injured [44]. In the analysis of the obtained X-ray diffraction patterns, attention was mainly paid to indirect signs of orbit damage — emphysema of soft tissues, hemosinus, discontinuous bone contour of the anterior and posterior borders of the paper plate of the internal wall of the orbit [44].

For the surgical treatment of patients with fractures of the orbital floor, an X-ray examination plays a key role in the diagnosis of injuries (Sandoval, H. M. et al., 2009). A radiographic examination of the facial skull in a half-axial projection allows assessing the state of the orbital floor, prolapse of the orbit contents and the air-liquid ratio in the maxillary sinus. According to Sandoval, H. M. et al. [44], significantly more complete information about the severity of damage can be received using computed tomography(CT) because CT allows assessing the condition of both osseous and soft tissue structures. Today, CT remains the main diagnostic method of choice for orbital injury (Sandoval, H. M. et al., 2009).

The procedure for reproducible orbit measurements in computed tomography(CT) was developed by Elijah Zhengyang Cai et al. [36]. Planes of reference for orbital fractures(PROF) were developed to standardize the measurements made during the orbital computed tomography(CT) scanning. This study describes the use of planes of reference for orbital fractures(PROF) to determine the location along the orbital floor where the posterior ledge(PL) is most commonly found. The transverse slope and the anteroposterior slope of the orbital floor were also measured (Elijah Zhengyang Cai et al., 2018).

Analysis of predictors of enophthalmos in adult patients who only have fractures of the orbital floor was obtained by Ahmad Nasir Suraya et al. [1]. Predisposing factors of enophthalmos in adult patients with only fractures of the orbital floor were determined by dentists in Malaysia and India using the CT method, 3D method, Osirix Lite Digital Imaging and Communications in Medicine Viewer version 7.0.1 (Geneva, Switzerland) Ahmad Nasir Suraya et al. [1], orbit scanning, digital technology, analytical method, visual method, exophthalmometer, clinical method. Planes of reference for orbital fractures(PROF) were developed to standardize the measurements made when scanning the orbit using computed tomography(CT). This study describes the use of planes of reference for orbital fractures(PROF) to determine the location along the orbital floor where the posterior ledge(PL) is most commonly found. The transverse slope and the anteroposterior slope of the orbital floor were also measured. This study evaluated a one-way orbital fracture while maintaining the infraorbital margin(IM) and a fracture of the infraorbital margin(IM) of the orbit. Computed tomography(CT) scanning of the face was carried out using Osirix Lite Digital Imaging and Communications in Medicine Viewer version 7.0.1 (Geneva, Switzerland). All skull positions were standardized in orientation in accordance with the Frankfurt and mid-sagittal planes. The distance of the posterior ledge(PL) from the infraorbital margin(IM) was determined in a sagittal form. The inclination of the orbital floor in the transverse and anteroposterior sections was measured on the coronal and sagittal planes, respectively. According to the analysis (Ahmad Nasir Suraya et al., 2018), for patients with an intact fracture of the infraorbital margin(IM), the average distances of the posterior ledge(PL) from the infraorbital margin(IM) were 22.1 mm (95% confidence interval(CI): 21.2 – 23.0) and 21.1 mm (95% CI: 20.2 – 21.9), respectively. The average transverse slope was 19.4 (95% CI: 18.3 – 20.5). The average anteroposterior slope was 15.5 (95% CI: 14.5 – 16.5). As was demonstrated by Ahmad Nasir Suraya et al., planes of support for orbital fractures are a simple and effective method for obtaining standardized measurements of the orbit cavity in computed tomography(CT). Understanding the most common location of the posterior ledge(PL) and the orientation of the orbital floor in three-dimensional(3D) space allows surgeons to perform prompt access and intervention with greater accuracy.

Post-traumatic enophthalmos(PE) is clinically assessed using a Hertel exophthalmometer(Hertel). A difference in axial displacement between two eye sockets of 2 mm or more is considered to be clinically significant, and this would indicate surgical intervention. Another assessment is carried out using CT images, as described by Ahmad Nasir Suraya et al.

Many studies have been conducted and have shown shocking findings in predicting the risks of post-traumatic enophthalmos(PE). Factors such as fracture site, fracture size, and muscle change have been identified as predictors of post-traumatic enophthalmos(PE). This study was designed to determine the prevalence of a pure orbital fracture and to investigate the relationship between the fracture site, size, medial and lower rectus muscle changes and the involvement of intraorbital structures with post-traumatic enophthalmos(PE) (Ahmad Nasir Suraya et al., 2018).

A clear orbital fracture is limited by the internal wall of the orbit (Ahmad Nasir Suraya et al., 2018). It does not include the orbital rim or other facial bones. Post-traumatic enophthalmos(PE) was described as the most debilitating complication of this fracture (Ahmad Nasir Suraya et al., 2018). Post-traumatic enophthalmos(PE) is clinically characterized as a displacement of the eyeball back. This can lead to impaired motor skills and diplopia. High incidence of PE from 30% to 62% has been reported (Ahmad Nasir Suraya et al., 2018).

Decisions for the treatment of orbital fractures are based on the clinical presentation, ophthalmological examination and CT. In the case of extensive fractures, decisions are easily made between conservative and surgical treatment. However, objective parameters are rare and unconvincing, therefore, the role of the evaluation scheme based on computed tomography(CT) in the decision-making on the treatment of isolated fractures of the orbital floor is increasing (Gesche Frohwittera et al., 2018).

Special attention is paid to the three-dimensional(3D) measurement of the symmetry of the zygomaticomaxillary complex(ZMC) using the damaged surface mirroring and matching method (Jean-Pierre T. F. Ho et al., Blumer et al., 2016). The presented method, according to Jean-Pierre T. F. Ho et al. [32], Blumer et al. [25], is an accurate tool for assessing the symmetry of the zygomatico-orbital complex(ZOC), which may be useful for advanced diagnosis and treatment assessment. A study by Blumer et al. [25], showed that 6 out of 7 actual implant placement revisions would be reviewed during the operation by all 4 experts if intraoperative imaging with virtual orbit reconstruction using a computer was used, which could be useful to prevent subsequent revisions of fractures of the orbital floor. In this study, the intraoperative threshold for revising implant placement seemed lower when using intraoperative imaging with virtual reconstructions, because researchers would check for significantly more cases during surgery. At the hospital and post-hospital stages, this threshold increases, which indicates a more important role of clinical results [25]. It is unclear whether surgeons would really review the same cases as experts if they used intraoperative imaging with virtual orbit reconstructions. However, intraoperative imaging with virtual orbit reconstruction using a computer helps rule out postoperative revisions of orbital fractures (Blumer et al., 2015).

The combination of surface mirroring and matching methods, 3D, CT, reconstruction methods was applied by Jean-Pierre T. F. Ho et al. [32], Blumer et al. [25], (the Netherlands). According to (Jean-Pierre T. F. Ho et al.; Blumer et al., 2016), three-dimensional(3D) virtual models of hard tissues can be reconstructed from CT statistics. In this case, the resulting models should be mirrored and overlap each other. To measure the total and maximum symmetry, the absolute average distance between the eyes and the angle of deviation of the pupil from 90 degrees should be used (Jean-Pierre T. F. Ho et al., Blumer et al., 2016). The intraclass correlation coefficient(ICC) should be calculated to measure the interaction coherence (Jean-Pierre T. F. Ho et al., Blumer et al., 2016). To determine if this method is applicable in the cases of fracture of the zygomatico-orbital complex(ZOC), Jean-Pierre T. F. Ho et al. [32], Blumer et al. [25], analyzed CT data of patients with a unilateral fracture of the zygomatico-orbital complex(ZOC). According to Jean-Pierre T. F. Ho, Blumer [32, 25], for an unaffected group, the average AD value (AD is the absolute average distance) was 0.84 ± 0.29 mm (95% confidence interval(CI) 0.72 – 0.96), and the average NPD value (NPD _ ninety percent distance) was 1.58 ± 0.43 mm (95% confidence interval(CI) 1.41 – 1.76). The ICC was 0.97 (0.94 – 0.98, as a 95% confidence interval(CI)), indicating an almost perfect match. In the affected group, according to figures (Jean-Pierre T. F. Ho et al.; Blumer et al., 2016), the mean AD value was 2.97 ± 1.76 mm (95% CI 1.71 – 4.23), and the mean NDP value was 6.12 ± 3.42 mm (95% confidence interval(CI) 3.67 – 8.57). The affected group showed an almost perfect agreement on interaction with ICC 0.996 (0.983 – 0.999, as 95% CI) (Jean-Pierre T. F. Ho et al., Blumer et al., 2016).

Obtaining postoperative images of maxillofacial fractures does not affect the clinical management of patients without symptoms. However, David Carpenter, Ronnie Shammas et al. [54], evaluated the role of postoperative imaging in the context of orbital fractures. They evaluated postoperative imaging in the treatment of orbital floor fractures in isolation and with concomitant facial fractures.

The orbital volume was measured using CBCT and Cranioviewer software in patients who underwent enucleation and orbital implantation (Olga Lukats et al., 2012).

A study on the impact of mirror computer programs on the decision to review reconstruction of orbital floor fractures evaluated the feasibility of intraoperative imaging using virtual reconstruction using a computer during reconstruction of orbital floor fractures (Blumer et al., 2015). The surgeon’s intention to review the reconstructed primary fracture of the orbital floor by evaluating postoperative specular computed tomography(CT) scans was analyzed during surgery prior to wound closing, during inpatient hospitalization and after hospitalization. This study showed that intraoperative imaging using virtual reconstruction using a computer can be useful to prevent subsequent revisions of orbital fractures (Blumer et al., 2015).

Postoperative changes in isolated fractures of the medial orbital wall based on computed tomography(CT) were studied by Soyeon Jung et al. [37]. From their point of view, the treatment was improved by accurately reducing the size of fractures, but nevertheless was limited to completely reduce the size due to the use of conventional techniques. The authors analyzed postoperative results using CT after the usual open reduction of an isolated fracture of the medial wall. This study is very limited so as to explain the changes in bone remodeling. Further research should be continued to find an understanding of the process (Soyeon Jung et al., 2017).

The negative vector of the orbit is defined as the most anterior globe portion, protrudes past the eminence of the zygomaticomaxillary complex(ZMC). The objective of the study of the role of the negative vector of the orbit in orbital blowout fractures(BOFs) by Soo Youn Choi et al., was to evaluate the relationship between the negative vector of the orbit and the localized fracture by analyzing the distance between the anterior surface of the cornea and orbital bone and soft tissues of the face in fractures of the medial and orbital floor using orbital CT (Soo Youn Choi et al., 2017).

Radiographic assessment of fractures of the ZOC is complicated by the difficulties of placing three-dimensional(3D) rotation and displacement under two-dimensional(2D) imaging mode. In particular, the location of the eminence of malar, which is crucial for establishing facial symmetry, is difficult to determine in two dimensions. Therefore, assessing the degree of fracture from an aesthetic point of view remains a clinical assessment. Currently, a new method for assessing a fracture of the ZOC has been introduced, which uses the three-dimensional(3D) imaging method to visualize and quantify the displacement of the eminence of malar in the anteroposterior, medial-lateral and upper-lower dimensions. Then, the nature of displacement correlates with the recommended intervention, representing a clinical assessment of the severity of a fracture, as well as the possible outcome (Candace Y. Pau et al., 2010).

Three-dimensional(3D) analysis of fracture patterns of the zygomaticomaxillary complex(ZMC) was carried out by Candace Y. Pau et al. [56].

The possibilities of reconstructing the orbit and adnexa of the eye in patients with injuries of the middle zone of the face are directly related to calculating the change in the volume of the orbit of the eyes and measuring the orbital floor in a fracture of the zygomatico-orbital complex(ZOC) (Malanchuk, V. A. et al., 2013). This method was used in the clinic of the Department of Surgical Dentistry and Oral and Maxillofacial Surgery of the NMU named after O. O. Bogomolets (Ukraine) from 2006 to 2011 years, where 143 patients with midface fractures of various prescriptions and etiological causes of onset were treated (Malanchuk, V. A. et al., 2013).

An anatomical study of the zygomaticomaxillary complex(ZMC) using three-dimensional(3D) computed tomography(CT) based on zygomatic implantation was performed by Xiangliang Xu et al. [2]. The navigation technique has recently come into use in zygomatic implantation (Xiangliang Xu et al., 2017). This is a valuable method, and it will play a more important role in surgical intervention if performed with more detailed anatomical information about the zygomaticomaxillary complex(ZMC) (Xiangliang Xu et al., 2017).

Prediction of diplopia is the most important criterion in planning a surgical procedure. The objective of Michaela Cellina et al. [53], was to determine the results of CT, which may indicate the presence of diplopia, when patients with “trapdoor fracture” of the orbital floor cannot be adequately examined to plan orbit repair. CT of all patients was retrospectively evaluated for blunt craniofacial injury. The following CT variables were assessed: fracture site, multifocal fracture, displacement of fragments, thickening of extraocular muscles (EOM _extraocular muscles), capture of extraocular muscles(EOM), displacement of extraocular muscles(EOM), engagement of extraocular muscles(EOM), intraconal and extraconal emphysema, intraconal and extraconal hematoma and hernia. All patients passed the Hess-Lancaster test to diagnose diplopia. After conducting a group comparison using the Pearson criterion χ^2, they derived their prediction model using logistic regression with diplopia as a forecast and CT variables as predictors. There were 299 patients with "explosive" orbital fractures, 46 (15.4%) with diplopia confirmed by the Hess-Lancaster test. CT variables with a statistically significant difference between the group with diplopia and the group without diplopia were as follows: orbital fracture (p = 0.014), displacement of fragments (p = 0.001), multifocal (p = 0.005), thickening of extraocular muscles(EOM) (p = 0.001), capture of extraocular muscles(EOM) (p < 0.001), displacement of extraocular muscles(EOM) (p < 0.001), hernia of fat tissue (p = 0.003). CT variables relevant as predictors of diplopia in multivariate analysis were as follows: orbital floor fracture (p-value 0.015; odds ratio 2.871, 95% odds ratio confidence interval(CI) 0.223 – 6.738), displacement of extraocular muscles(EOM) (p-value 0.001; odds ratio 10.693, 95% odds ratio confidence interval(CI) 3.761 – 30.401), capture of extraocular muscles(EOM) (p-value 0.001; odds ratio 11.510, 95% odds ratio confidence interval(CI) 3.059 – 43.306). The presence of diplopia can be assumed based on the results of CT after an orbital injury.

The objective of the study in assessing fractures of the zygomatico-orbital complex(ZOC) using *U/S* McCann, P. J. et al. [30], was to study the sensitivity and reliability of ultrasound for detecting fractures of the zygomatico-orbital complex(ZOC) and their boundaries. These studies led to the conclusion that the use of ultrasound is an actual method for visualizing facial injury as an initial study and aims to help reduce the total number of radiographs needed to diagnose fractures of the zygomatico-orbital complex(ZOC) (McCann, P.J. et al., 2000).

To assess suspected fractures of the zygomatico-orbital complex(ZOC), English dentists resorted to ultrasound or the X-ray method, the digital technology method, and the imaging method. In each case, both conventional X-ray and ultrasound examinations were performed. Ultrasound imaging was performed in five areas: the infraorbital margin(IM), the lateral wall of the maxillary sinus, the zygomatic arch, the anterior-zygomatic process and the orbit. Both X-ray and ultrasound results were correlated with intraoperatively obtained data. The coincidence of the results was 85% between the X-ray and ultrasound scans. Ultrasound imaging was most reliable on the lateral wall of the maxillary sinus, where the coincidence in sensitivity level was 94%, and in terms of specificity (borders of the fracture of the zygomatico-orbital complex(ZOC)) – 100%. The positive predictive value in this area was 100% compared with X-ray evidence (McCann, P. J. et al., 2000).

Su Hyun Choi et al. [8], predicted late enophthalmos using preoperative orbital volume and fracture area measurements for explosive fracture of the orbital floor. Enophthalmos caused by orbital volume expansion is a traditional indication for surgery in an orbital blowout fracture(BOF), but it may not appear immediately after an orbital injury due to periorbital edema. The work objective was to study the correlations of the orbital volume ratio(OVR) and the orbital fracture area(OFA) with the measurement of late enophthalmos with a one-sided clean fracture (Su Hyun Choi et al., 2017).

The objective of the study (Bruneau, Stéphane et al., 2016) was to determine the predictive value of a specific CT-based computed tomographic assessment for the final functional ophthalmological outcome in clean orbital fractures. We analyzed data from 34 consecutive patients with just orbital blowout who underwent a period of at least 6 months of medical and ophthalmological observation. The following 3 CT-based parameters were included: area ratio of the fractured(RF) orbital floor, maximum height(MH) of periorbital tissue herniation and 4-grade muscular subscore(MSS), which describes the displacement of the lower rectus muscle relative to the level of the floor. Orthoptic complications(diplopia, enophthalmos and limitation of ocular motility) were assessed by an experienced strabologist. The predictive value of the CT parameters was analyzed using the curve feature diagrams of patients who underwent surgery, as well as the feature diagrams of the area under the curve(AUC), logistic regression and Spearman correlation, the area ratio of the fractured(RF) orbital floor had a significant predictive value for the development of enophthalmos(area under the curve(AUC) = 0.75, P = 0.02), and the maximum height(MH) of periorbital tissue herniation for diplopia(area under the curve(AUC) = 0.80, P = 0.03). Among patients with complications, the relevance of the muscular subscore(MSS) and the maximum height(MH) of periorbital tissue herniation, as well as the severity of the vertical displacement, were also clinically closely related(rho = -0.52 and -0.56). The study conducted by Bruneau, Stéphane et al. [7], revealed significant predictive value of the area ratio of the fractured(RF) orbital floor for the development of enophthalmos and the maximum height(MH) of periorbital tissue herniation to preserve diplopia. Although it is not statistically possible to predict the development of limitation of ocular motility the maximum height(MH) of periorbital tissue herniation and muscular subscore(MSS) clinically highly correlated with the severity of limitations of eye displacement (Bruneau, Stéphane et al., 2016).

The determination of the predictive value of a specific CT-based assessment in determining the diagnosis of the final functional ophthalmological outcome for clean orbital floor fractures was carried out by Bruneau, Stéphane, and others [7]. The results of the study showed that although it is not statistically possible to predict the development of limitation of ocular motility, the maximum height(MH) of periorbital tissue herniation and muscular subscore(MSS) clinically highly correlate with the severity of limitations of eye displacement (Bruneau, Stéphane et al., 2016).

Methods for prototyping damages to the ZOC are based on modeling osseous structures of the orbit and zygomatic bone based on data obtained with MSCT or CBCT. Digital surgical templates for the treatment of extensive damages to the ZOC can be associated with a change in orbital volume (quantification). The study conducted by Xiang-Zhen Liu et al. [16], attempted to present 3 virtual surgical planning and digital rapid prototyping(RP) templates for damages to the zygomaticomaxillary complex(ZMC) associated with changes in orbital volume, and to quantify the results of surgical intervention (Xiang-Zhen et al., 2013).

Individual repair of the orbital wall using the three-dimensional(3D) model of a rapid prototype(RP) in patients with a fracture of the orbital wall is presented in the works of Oh, Tae Suk et al. [14]. The essence of the work is that due to their complex three-dimensional(3D) structure of the model of a rapid prototype(RP) of the orbital wall, it is difficult to restore the original orbital contours. In addition, a slight improper placement of an implant can lead to enophthalmos or other complications. The authors describe the experience of using individualized implants with a Medpor titanium mesh and stereolithographic modeling in a number of patients who underwent repair of the orbital wall (Oh, Tae Suk et al., 2016). The state of the internal orbit after the reduction of fractures of the zygomatico-maxillary complex(ZMC) was related by Ellis, E. 3rd, etc. [17], to the determination of the state of the internal orbit before and after the reduction of fractures of the zygomatic-maxillary complex(ZMC) during treatment without repairing the internal orbit (Ellis, E. 3rd, etc., 2004).

A study of the orbital fracture using a three-dimensional(3D) printer was conducted by Bastien Valding et al. [47]. Over the past 10 years, the use of 3D printing has increased significantly in medicine, especially in maxillofacial surgery. Many different programs and printers are available on the market, but the problem is that it’s hard to choose which one best meets your needs. It is necessary to analyze the need for such programs, as well as their quality, before investing in 3D printing (Bastien Valding et al., 2018). Bastien Valding et al., 2018, compared 3D printing of an orbital fracture between professional and non-professional software. The results show that print quality and preparation time vary greatly. The costs between free or professional software should also be taken into account.

Explosive fractures affect the volume and surface area of the orbital cavity. Assessing these values after an injury can help decide if the patient is a candidate for surgery. Recent studies have provided estimates of the orbital volume and the bone defect area and correlated them with the degree of enophthalmos. However, a large degree of biological variability between individuals may prevent these absolute values from being successful indicators for surgery. Stereological methods have been used to assess the volume of the orbital cavity in several studies, but to date, they have not been used to determine the surface area. This is the first study in which the entire surface area of the orbital cavity was measured based on computed tomography(CT) with high image quality (Felding, Ulrik Ascanius et al., 2016).

The objective of the study conducted by Huang, Li et al., was to accurately assess the severity of traumatic orbit defects and personalized orbit repair methods using a radiological indicator as an estimate in the treatment of clean orbital floor fractures. A retrospective study (Huang, Li et al., 2017), was conducted on 97 patients with traumatic orbital defects. All the patients were screened before and after helical computed tomography(CT). The spatial orientation technique was used to measure the three-dimensional(3D) position of the globe and calculate changes in the orbital volume. Subsequently 34, computer technology(CT) and the rapid prototyping(RP) method were used to create a personalized orbital model to help plan the operation, as well as the preliminary formation of implants and bone plates. During the operation, the contents of orbital hernia were returned; preformed Medpor titanium mesh or other implants were placed; the orbital shape at the defect site was accurately restored; and normal proportions between the orbital walls and the contents of the orbit were restored. The treatment results were assessed in terms of appearance after an operation, patient satisfaction, ophthalmological examination, and computed tomography(CT). The complications were analyzed accordingly. Satisfactory results were achieved in all the patients with the following exceptions: 1 patient with unsatisfactory facial appearance; 2 patients with an old trauma and adverse enophthalmos correction who experienced diplopia without significant improvement within 6 months after surgery; and 2 patients with mild postoperative lower eyelid ectropion. All other patients achieved satisfactory treatment results, that is, the orbital shape at the defect site was accurately restored, and normal proportions between the orbital walls and the contents of the orbit were restored. There were no other serious complications. In patients with traumatic orbit defects, accurate digital estimates of the three-dimensional(3D) position of the eyeball and changes in orbit volume help plan surgical procedures using a personalized model and facilitate early surgery with minimal trauma. When the orbit volume was restored and the position of the eyeball was maintained or corrected, the precise reconstruction of the anatomical shape of the orbit was simultaneously completed. Thus, personalized orbit reconstruction can increase the effectiveness of plastic surgery in patients with orbital deformities (Huang, Li et al., 2017).

Stereological methods using the dimensions of the orbital cavity based on computed tomography(CT) with high-quality images obtained on the heads of corpses, automated computer software, projection method, digital technology, imaging method were used as an addition (Denmark). The volume and surface area of the orbital cavity were assessed on the basis of computed tomography(CT) of 11 cadaveric heads with fractures of the zygomatico-orbital complex(ZOC). Measurements showed that the average (± SD) total volume and the total surface area of the orbital cavities were 24.27 ± 3.88 cm and 32.47 ± 2.96 cm, respectively. There was no significant difference in volume (P = 0.315) or surface area (P = 0.566) between the two orbital cavities. The stereological method has proven to be a reliable and impartial method that can be used as the gold standard for comparison with automated computer software. Further imaging studies for fractures of the zygomatico-orbital complex(ZOC) in patients with fractures of the zygomatico-orbital complex(ZOC) with disruption of the orbit can be based on individual and relative calculations, including both the hernia volume and the fracture surface area with respect to the total volume and the surface area of the intact orbital cavities (Felding, Ulrik Ascanius et al., 2016).

Methods of intraoperative imaging and navigation surgery In intraoperative imaging using a 3D C-arm system after reducing a fracture of the ZOC, the objective of the researchers Frank Wilde et al. [26], was to assess the usefulness of intraoperative three-dimensional(3D) visualization of the C-shaped arch to determine the adequacy of fracture reduction. Intraoperative 3D imaging can help decide whether the orbit should also be restored (Frank Wilde et al., 2012).

Navigation surgery as a way to increase the accuracy of reducing unilateral complicated fractures of the zygomatico-orbital complex(ZOC) is one of the components of a randomized controlled study (Xiao Zhang et al., 2018). The face occupies the most prominent position in the human body, which makes it vulnerable to injury (Xiao Zhang et al., 2018). Patients suffering from fractures of the zygomatico-maxillary complex(ZMC) always have deformation, because the zygomatico-maxillary complex(ZMC) greatly contributes to the width and protrusion of the midface (Xiao Zhang et al., 2018). Consequently, the precise reduction in fractures of the zygomatico-maxillary complex(ZMC) is critical for restoring a satisfactory face line (Xiao Zhang et al., 2018). For invert fractures, open reduction internal fixation(ORIF) should be considered as the main and reliable option for restoring the appearance (Xiao Zhang et al., 2018). However, fractures are quite difficult to treat, especially in the cases of complex fractures of the zygomatico-maxillary complex(ZMC). Complex fractures of the zygomatico-maxillary complex(ZMC) refer to comminuted fractures, fractures with delayed surgery and/or bone defects of the zygomatico-maxillary complex(ZMC). Having no available guidelines for anatomical reduction, surgeons treat fracture fragments mainly in accordance with their own clinical experience, which often leads to unsatisfactory results of excessive or insufficient recovery (Xiao Zhang et al., 2018). The refusal of anatomical reduction will lead to an incorrect width and protrusion of the cheekbone and asymmetry of the midface, and can also lead to poor self-esteem and health problems associated with poor quality of life. Thus, reducing the distance between the adjacent parts of fractures is the key to treating complex fractures of the zygomatico-maxillary complex(ZMC) (Xiao Zhang et al., 2018). With the rapid development of computer technology, navigation surgery has gradually become a new auxiliary tool for diagnosis, surgery planning and treatment in medicine (Xiao Zhang et al., 2018). To synchronize the actual surgical anatomy in real time with the imaging of the patient's anatomy previously obtained using computed tomography(CT), navigation surgery was first used in neurosurgery and gained recognition (Xiao Zhang et al., 2018). In recent years, navigation surgery has been used in many surgical procedures, such as removal of foreign body, tumor resection, epithesis, and implantation (Xiao Zhang et al., 2018). These studies have shown that accurate and predictable results have been achieved with navigation surgery. It is still uncertain whether navigation surgery really improves the accuracy of the reduction of complex fractures of the zygomatico-maxillary complex(ZMC) (Xiao Zhang et al., 2018). In this study, a randomized controlled clinical study was carried out to compare the effects of treating complex fractures of the zygomatico-maxillary complex(ZMC) with navigation surgery and without it. Scheduling software was used to model the surgical movements of bone fractures based on preoperative images, and intraoperative navigation surgery was used for accurate reduction. Navigation surgery for the treatment of fractures of the ZOC can lead to a significant improvement in the accuracy of reductions, which should become an integral part of surgical therapy (Xiao Zhang et al., 2018).

The use of a computer-assisted navigation system(CANS) in the delayed treatment of zygomatic fractures is also one of the components of a randomized controlled study and is associated with the fact that the delayed treatment of a fracture of the upper jaw ZOC is challenging for surgeons, since the objective of this study is to compare the therapeutic effects of delayed surgery for fractures of the ZOC with a computer-assisted navigation system(CANS) and without it (Xi Gong et al., 2017).

Navigation surgery as a way to increase the accuracy of reducing unilateral complicated fractures of the zygomatico-maxillary complex(ZMC) uses Geomagic Studio 11 software and Brainlab iPlan CMF 3.0, random sampling for analysis, pre- and postoperative analysis of data, visual method, analytical method.

Accurate reduction is the key to successful treatment of bone fractures [49]. In a complex fracture of the ZOC, as one of the most complex fractures of the facial bone, it is often difficult to achieve accurate reduction, which leads to facial deformation. This study included 20 patients with unilateral complicated fractures of the zygomatico-maxillary complex(ZMC), randomly divided into experimental and control groups, with navigation surgery and without it, respectively. Pre- and postoperative imaging data was collected and then analyzed using Geomagic Studio 11 software and Brainlab iPlan CMF 3.0. A more accurate reduction was shown in the experimental group based on the results of measurements of both programs than in the control group. It can be concluded that navigation surgery has shown great value in performing accurate reductions in complex fractures of the zygomatico-maxillary complex(ZMC) and restoration of the face line (Surgical navigation improves reductions accuracy of unilateral complicated zygomaticomaxillary complex(ZMC) fractures: a randomized controlled trial) (Xiao Zhang et al., 2018).

The delayed treatment of a fracture of the ZOC and the upper jaw is challenging for surgeons. The objective of the study by Xi Gong et al., was to compare the therapeutic effects of delayed surgery for fractures of the ZOC with a computer-assisted navigation system(CANS) and without it.

A randomized clinical study using random sampling included patients with a unilateral fracture of the zygomatico-maxillary complex(ZMC) who were randomized 1: 1 with delayed treatment with CANS or without it. The primary result measurement were absolute bilateral differences in eminence and width of the zygomatico-maxillary complex(ZMC) based on CT data 48-72 hours after surgery. The fact that 103 patients with a unilateral fracture of the zygomatico-maxillary complex(ZMC) without immediate treatment, and 78 with immediate treatment were randomized to each group refer to the results. Postoperative CT measurements showed that the bilateral difference in eminence of the zygomatico-maxillary complex(ZMC) was significantly less for the navigation group than for the control group (1.24 vs 2.22 mm; $P < 0.001$). The bilateral difference in the width of the zygomatico-maxillary complex(ZMC) was not significantly different between the two groups (0.94 vs 1.36 mm; $P = 0.061$). The percentage of patients with a morphologically symmetrical face (bilateral differences of ≤2 mm in eminence and width of the zygomatico-maxillary complex(ZMC)) was 71.8% (28 of 39) for the navigation group and 35.9% (14 of 39) for the control group ($P = 0.001$). Photogrammetry showed that the average difference between postoperative CT data and preoperative design was less in the navigation group (1.30 vs 2.40 mm; $P = 0.012$).

It can be said that the use of CANS improved the symmetry of the zygomatico-maxillary complex(ZMC) in patients with a unilateral fracture of the zygomatico-maxillary complex(ZMC), who postponed treatment, which made it possible to more accurately implement the preoperative plan (Xi Gong et al., 2017).

Jinhwan Park et al. [42], reconstructed a large orbital fracture of the posterior wall of the floor taking into account the orbital angulation of the orbital floor using an endoscope. Reconstructing a large orbital fracture extending to the posterior wall of the maxillary sinus is a great challenge. In this study, the authors present a transconjunctival or transcaruncular approach using endoscopy and layered porous polyethylene barrier sheets to control a large orbital fracture of the floor wall (Jinhwan Park et al., 2017).

Extensive fractures of the orbital floor and the medial wall compared to solitary fractures of the orbital wall are more likely to require surgical correction due to the higher likelihood of complications such as diplopia, enophthalmos or numbness. The unique and compound contours of the orbital anatomy limit the intraoperative overview of the intraorbital anatomy, and the complex fractures of the orbit, including the support of the transition zone, make the reconstruction of the orbit more difficult. The objective of this study was to describe the experience of surgical approaches using navigation and endoscopic guidance for extensive reconstruction of a fracture of the floor and the medial wall (Jia-Ruei Yang et al., 2019).

A study by Blumer et al. [25], showed that 6 out of 7 actual implant placement revisions would be reviewed during the operation by all 4 experts if intraoperative imaging with virtual orbit reconstruction using a computer was used, which could be useful to prevent subsequent revisions of fractures of the orbital floor [25]. In this study, the intraoperative threshold for revising implant placement seemed lower when using intraoperative imaging with virtual reconstructions, because researchers would check for significantly more cases during surgery. At the hospital and post-hospital stages, this threshold increases, which indicates a more important role of clinical results [25]. It is unclear whether surgeons would really review the same cases as experts if they used intraoperative imaging with virtual orbit reconstructions. However, intraoperative imaging with virtual orbit reconstruction using a computer helps rule out postoperative revisions of orbital fractures (Blumer et al., 2015).

The feasibility of intraoperative imaging using virtual computer reconstruction of orbital floor fractures, the influence of mirror CT scans on the decision to review treatment has been resolved (Blumer et al., 2015). These virtual computer reconstructions have been consistently studied by experts. The results showed a firm agreement among researchers regarding the revision of anatomically incorrectly reduced fractures of the orbital floor during surgery by assessing postoperative mirror CT scans. This analysis of postoperative CT scanners with computer virtual orbit reconstructions would lead to a significantly larger number of revisions during surgery, but all actual revisions were identified, except for 1 case. This case was the same for all examiners. The timing of surgery would be extended in additional revised cases, but a better anatomical reconstruction would be achieved. In addition, the intraoperative result of the reconstruction should be monitored instantly and corrected immediately, if necessary [25].

Preoperative and postoperative functional and aesthetic results have been described by using the navigation and endoscopic reconstruction method (Jia-Ruei Yang et al., 2019).

At the present time, to assess damage to the orbital floor and the ZOC, comprehensive diagnosis is required, including the use of clinical methods, radiological methods and prototyping to determine indications for a particular type of conservative or surgical treatment and the role of a CT-based evaluation scheme in deciding on the treatment of orbital floor fractures. The size of the fracture defect is apparently largely associated with the presence of diplopia. CT morphological parameters and preoperative ophthalmic results showed statistical significance for diplopia and loss of the inferior rectus muscle(IRM), diplopia and displacement of the inferior rectus muscle(IRM), decreased motility and contraction of the inferior rectus muscle(IRM), as well as decreased motility and displacement of the inferior rectus muscle(IRM). Defects of the critical size of the orbital floor of ≥ 2 cm² can cause a clinically significant displacement of the posterior eyeball, leading to enophthalmos, therefore, patients requiring surgical intervention should be identified (Gesche Frohwittera et al., 2018).

The role of intraoperative imaging using the 3D C-arm system after reducing a fracture of the zygomatico-orbital complex(ZOC) in the treatment of fracture is that it assesses the adequacy of the fracture in the treatment of fractures both by using the method of closed repair and by using the method of open reduction restoration and internal fixation of the zygomatico-orbital complex(ZOC). The objective was the value of the usefulness of intraoperative three-dimensional(3D) imaging of the C-shaped arch for assessing the adequacy of fracture reduction. During the restoration of fractures of the zygomatico-orbital complex(ZOC), the lateral wall of the orbit and/or the orbital floor are often reduced by a simple reduction of the cheekbone. Intraoperative 3D imaging can help decide whether the orbit should also be restored. The results showed that after a reduction in fractures of the zygomatico-orbital complex(ZOC), intraoperative 3D scanning showed inadequate restoration of the orbital floor and inadequate restoration of the lateral orbit it was necessary to reduce the fracture of the zygomatic arch and zygomatic bone. Postoperative imaging shows whether the patient needs a second operation. The intraoperative 3D imaging with a C-shaped bottom is apparently an effective tool for assessing the reduction in fracture of the zygomatico-orbital complex(ZOC), which helps to avoid additional procedures and, thus, reduce the incidence. In addition, there is no need for postoperative imaging (Frank Wilde et al., 2012).

It can be concluded that navigation surgery as a treatment coordinator plays a major role in the precise reduction of complex fractures of the zygomatico-maxillary complex(ZMC) and restoration of the face line, it can be considered the key to the successful treatment of fractures (Xiao Zhang et al., 2018).

In a complex fracture of the zygomatico-maxillary complex(ZMC), as one of the most complex fractures of the facial bone, it is often difficult to achieve accurate reduction, which leads to facial deformation. This study included patients with unilateral complicated fractures of the zygomatico-maxillary complex(ZMC), randomly divided into experimental and control groups, with navigation surgery and without it, respectively. Pre- and postoperative imaging data was collected and then analyzed using Geomagic Studio 11 software and Brainlab iPlan CMF 3.0. A more accurate reduction was shown in the experimental group based on the results of measurements of both programs than in the control group (Xiao Zhang et al., 2018).

The delayed treatment of fracture of the zygomatic complex of the upper jaw is challenging for surgeons. Comparing the therapeutic effects of delayed surgery of fractures of the zygomatico-maxillary complex(ZMC) with a computer-assisted navigation system(CANS) and without it leads to the conclusion that the use of CANS improves the symmetry of the zygomatico-maxillary complex(ZMC) in patients with a unilateral fracture of the zygomatico-maxillary complex(ZMC), who postponed treatment, which allows more accurately implement the preoperative plan (Xi Gong et al., 2017).

The combined use of the X-ray method and clinical examination allows to adequately assess the indications for the operation and its result. When assessing the radiological indicator in the treatment of clean orbital floor fractures, Flore Roul-Yvonnet et al., sought to further assess the predictive power and relevance of the previously published radiological score for clean fractures with recording clinical data. Flore Roul-Yvonnet et al., retrospectively included all patients who were treated at the authors' office for a clean orbital fracture from June 2012 to November 2013. Flore Roul-Yvonnet et al., collected clinical data, including diplopia and enophthalmos at the initial stage and after 3 months of observation. X-ray data were also recorded: the frequency of fractures of the orbital floor, the maximum height(MH) of periorbital tissue herniation in a fracture of the orbital floor, and a general 4-grade muscular subscore(MSS) was given. The treatment determinants were assessed using a one-way analysis, with χ-tests or Fisher's exact tests for qualitative variables, and Student's t-tests for quantitative ones. Then a multivariate analysis was performed with stepwise logistic regression. Flore Roul-Yvonnet et al., proposed a simple indicator (with a specificity of 79% and a sensitivity of 56%) to indicate surgery, using an indicator that was a significant predictor of treatment in a multivariate analysis. The study conducted by Flore Roul-Yvonnet et al., is another step in standardizing the decision to treat clean orbital floor fractures. The proposed assessment requires confirmation of clinical studies, but already helps compare series of patients [20].

The combination of the intraoperative imaging method using the 3D C-arm system after reducing a fracture of the zygomatico-orbital complex(ZOC), the CT method, digital technology method, clinical method, method of scanning fractures of the zygomatico-orbital complex(ZOC) was applied (Frank Wilde et al., 2012)

(Germany). The results of this combination of methods showed that during the restoration of fractures of the zygomatico-orbital complex(ZOC), the lateral wall of the orbit and/or the orbital floor often decrease due to a decrease in the volume of the cheekbone, Frank Wilde et al. [26].

The German Dental School makes decisions on the treatment of orbital floor fractures based on the clinical picture obtained by an ophthalmological examination, and CT, digital technology, statistical method, standard method, scanning method, projection method. Decisions for the treatment of orbital fractures are based on the clinical presentation, ophthalmological examination and CT. However, objective parameters are rarely used in non-standard cases. An example is the retrospective study of Gesche Frohwittera et al., 2018, which included the observation of 106 patients with unilateral solitary fractures of the orbital floor. A correlation was made between preoperative ophthalmological examinations and specific CT parameters. According to the authors, the size of the fracture defect is largely associated with the presence of diplopia. The CT method with morphological parameters and preoperative ophthalmic results showed statistical probability for diplopia and loss of the inferior rectus muscle(IRM), diplopia and displacement of the inferior rectus muscle(IRM), decreased motility and contraction of the inferior rectus muscle(IRM), as well as decreased motility and displacement of the inferior rectus muscle(IRM) (Gesche Frohwittera et al., 2018). The clinical evaluation scheme for CT scanning of orbital fractures is aimed, according to Gesche Frohwittera et al., at facilitating the decision-making on treatment using four CT-based variables. Since defects of the critical size of the orbital floor of ≥2 cm² can cause a clinically significant displacement of the posterior eyeball, leading to enophthalmos, the parameters proposed by the researchers, based on a combination of the above methods, offer an easily accessible and easy to evaluate scheme that helps identify patients who need surgical intervention [19].

It is necessary to take into account the role of the negative vector of the orbit in orbital blowout fractures(BOFs) during treatment. The negative vector of the orbit is defined as the most anterior globe portion, protrudes past the eminence of the zygomaticomaxillary complex(ZMC). The objective of the study was to assess the correlation between the negative orbit vector and a localized fracture by analyzing the distance between the anterior surface of the cornea and the orbital bone with soft tissues of the face in medial and orbital blowout fractures(BOFs) using orbital CT. Patients with a diagnosis of fractures with a fracture involving the medial or orbital floor were studied. Distances from the anterior cornea to lower lid fat, the orbital floor, the lower orbital margin and the mass of the anterior cheek were measured using orbital computed tomography(CT). The ratio of the negative vector of the orbit and the measured distance was compared between a fracture of the medial wall and an orbital blowout fracture(BOF). Medical records, including age, gender, concomitant ophthalmic diagnosis and the nature of an injury, were analyzed retrospectively. 43 eyes of 43 patients with a diagnosis of a fracture of the medial wall and 34 eyes of 34 patients with a diagnosis of a fracture of the orbital floor. There was no significant difference in the distance from the anterior cornea to lower lid fat ($P = 0.574$), inferior orbital wall ($P = 0.494$) or orbital rim ($P = 0.685$). The distance from the anterior cornea to the anterior buccal mass was significantly different with a fracture of the medial wall (-0.19 ± 3.49 mm) compared with a fracture of the orbital floor (-1.69 ± 3.70 mm), $P = 0.05$. The negative vector of the orbit was significantly higher in patients with fractures of the orbital floor (70.6%) compared with patients with fractures of the medial wall (44.2%) ($P = 0.04$). Patients with a negative ratio of the orbit vector, when the most anterior portion of globe protruded past the anterior cheek mass and the malar eminence(ME), had a higher probability of developing an orbital floor fracture than a fracture of the medial wall (Soo Youn Choi et al., 2017).

According to Yukito Yamanaka (Japan) et al. [24], objective methods are required to evaluate preoperative and postoperative eye surgery, such as: digital technology method, HAR% method, diagram method, classification method, analytical method. The objective of this study was to determine the best terms for surgical recovery of orbital blowout fractures(BOFs) using the Hess area ratio(HAR%) for an objective assessment of ocular motility [24]. Numerous previous studies (Yukito Yamanaka et al., 2018), emphasizing the presence of diplopia, did not refer to objective data on ocular motility. To objectively assess eye motility, a Hess screening test was used, which helped track changes in eye motility in patients with eye fractures. In the case of an orbital fracture, eye muscle dysfunction within 30 degrees can be easily identified. Furuta et al., reported that diplopia was estimated using the Hess area percentage ratio(HAR%) based on the Hess diagram. In addition, according to Pier et al., HAR% is effective in predicting postoperative diplopia in patients undergoing surgical orbit repair.

An example of a measurement analysis for a zygomatico-orbital complex(ZOC) injury can be a three-dimensional(3D) analysis of patterns(samples) of fractures of the zygomatico-maxillary complex(ZMC) using the 3D method, CT, 2D method, radiography method, clinical method, plane method, digital technology method, imaging method, projection method, algorithm method, classification method (Candace Y. Pau et al., 2010). A new method for analyzing the fracture pattern of the ZOC uses 3D imaging of CT images to record the displacement of the malar eminence(ME) in a three-dimensional(3D) coordinate plane. The nature of the fracture correlated with the treatment outcome. CT on the face of patients with unilateral fractures of the ZOC and fractures of patients without fractures. The displacement of the malar eminence(ME) on the broken side was determined in the medial-lateral (x), upper-lower (y) and anteroposterior (z) measurements, as well as the Euclidean distance compared to the zygomatic buttress, which is located on the inextricable side. The initial natural variance of asymmetry was taken into account by comparing the location of the zygomatic buttress on the left and right of subjects without fractures. Patients who needed an open reduction in internal fixation(ORIF) to repair a single fracture of the ZOC had significantly larger cumulative displacements of the zygomatic buttress than patients who did not need an open reduction of internal fixation(ORIF) ($p = 0.02$). In addition, in patients with a high fracture rate of 3, 4 or 5 (assigned on the basis of severity in each measurement), the open reduction of internal fixation(ORIF) was significantly higher than in patients with a low fracture rate of 0.1 or 2 ($p = 0.05$). A severe displacement in one or several dimensions was associated with higher rates of open reduction of internal fixation(ORIF) than it was observed in patients with only neutral or slight displacements in all dimensions (p = 0.05). Severe displacement x was most strongly correlated with surgery (p = 0.02). In general, as shown by observations of Candace Y. Pau et al., restoring the orbital floor was less closely associated with most displacement measures than only restoration of the zygomatic-maxillary complex(ZMC); however, patients who needed restoration of the orbital floor had a greater displacement of the Euclidean zygomatic buttress than patients who did not require restoration of the orbital floor (p = 0.02). The severity of a fracture, determined by many parameters in the new assessment system, is associated with higher rates of open reduction of internal fixation(ORIF) in patients with unilateral fractures of the ZOC. Thus, the determination of the nature of a fracture of the ZOC can be informative when considering treatment options [56].

The method of the Cooter-David alphanumeric assessment system for patients with fractures of the maxilla of the orbital floor and its relationship with the results of the traditional method and reconstruction method are described by S. T. O'Sullivan, et al. [33].

The role of a specific computed tomographic(CT) assessment in determining the diagnosis of an ophthalmic outcome in fractures of the orbital floor only was determined using the diagram method, ophthalmic observation data, statistical method, clinical method, digital technology, analytical method [7]. The data of 34 patients with orbital blowout fractures(BOFs) only who underwent a period of at least 6 months of medical and ophthalmological observation were analyzed. The following 3 CT-based parameters were included: the area ratio of the fractured(RF) orbital floor, the maximum height(MH) of periorbital tissue herniation and the 4-grade muscular subscore(MSS) describing the displacement of the lower rectus muscle relative to the level of the floor. Orthoptic complications(diplopia, enophthalmos and limitation of ocular motility) were assessed by an experienced strabologist. The predictive value of the CT parameters was analyzed using the curve feature diagrams of patients who underwent surgery, as well as the feature diagrams of the area under the curve(AUC), logistic regression and Spearman correlation, the area ratio of the fractured(RF) orbital floor had a significant predictive value for the development of enophthalmos (area under the curve(AUC) = 0.75, P = 0.02), and the maximum height(MH) of periorbital tissue herniation for diplopia. Among patients with complications, the relevance of the muscular subscore(MSS) and the maximum height(MH) of periorbital tissue herniation, as well as the severity of the vertical displacement, were also clinically closely related (rho = -0.52 and -0.56). This study revealed significant predictive value of the area ratio of the fractured(RF) orbital floor for the development of enophthalmos and the maximum height(MH) of periorbital tissue herniation to preserve diplopia.

The CT method in predicting diplopia for orbital blowout fractures(BOFs) is used in combination with the digital technology, standard method, statistical method, test method, modeling and analytical methods (Michaela Cellina et al., 2017, Italy). Management of orbital blowout fractures(BOFs) is controversial: Assessment of diplopia is the most important criterion in planning a surgical procedure. The objective was to determine the results of CT, which may indicate the presence of diplopia, when patients with “trapdoor fracture” of the orbital floor cannot be adequately examined to plan orbit repair. CT scans of all patients with blunt craniofacial injury were retrospectively assessed (N = 3334). The following CT variables were assessed: fracture site, multifocal fracture, displacement of fragments, thickening of extraocular muscles(EOM), capture of extraocular muscles(EOM), displacement of extraocular muscles(EOM), engagement of extraocular muscles(EOM), intraconal and extraconal emphysema, intraconal and extraconal hematoma and hernia. All patients passed the Hess-Lancaster test to diagnose diplopia. After conducting a group comparison using the Pearson criterion χ^2, a prediction model was derived using logistic regression with diplopia as a forecast and CT variables as predictors. 299 patients with "explosive" orbital fractures were monitored, 46 (15.4%) with diplopia confirmed by the Hess-Lancaster test. CT variables with a statistically significant difference between the group with diplopia and the group without diplopia were as follows: orbital fracture (p = 0.014), displacement of fragments ($p = 0.001$), multifocal ($p = 0.005$), thickening of extraocular muscles(EOM) ($p = 0.001$), capture of extraocular muscles(EOM) ($p < 0.001$), displacement of extraocular muscles(EOM) ($p < 0.001$), hernia of fat tissue ($p = 0.003$). CT variables relevant as predictors of diplopia in multivariate analysis were as follows: orbital floor fracture (p-value 0.015; odds ratio 2.871, 95% odds ratio confidence interval(CI) 0.223–6.738), displacement of extraocular muscles(EOM) (p-value 0.001; odds ratio 10.693, 95% odds ratio confidence interval(CI) 3.761–30.401), capture of extraocular muscles(EOM) (p-value 0.001; odds ratio 11.510, 95% odds ratio confidence interval(CI) 3.059–43.306). The presence of diplopia can be assumed based on the results of CT after an orbital injury.

In identifying the role of postoperative imaging after a fracture of the orbital layer, the clinical method, digital technology method, imaging method, and the projection method were used. Obtaining postoperative images of maxillofacial fractures does not affect the clinical management of patients without symptoms. However, several studies have evaluated the role of postoperative imaging in the context of orbital fractures (David Carpenter, Ronnie Shammas, et al., 2018). The above methods and their role in postoperative imaging in the treatment of orbital floor fractures in isolation and with concomitant facial fractures were assessed in a retrospective review of patients who underwent open reduction and internal fixation(ORIF) of orbital floor fractures in the period. Surgical and perioperative recordings were examined to refer clinical results with postoperative imaging patterns for all identified orbital floor fractures, 54% had a ZOC damage, 46% had isolated orbital floor fractures, 39% had postoperative imaging, 70% had postoperative imaging in the absence of clinical symptoms. Patients with fractures of the ZOC underwent a significantly larger number of studies of postoperative imaging ($p < 0.001$); however, there were no differences in complications between isolated orbital and orbital fractures and ZOC. Postoperative observation(imaging) is not justified in the absence of persistent clinical symptoms after open reduction and internal fixation(ORIF) of orbital floor fractures (David Carpenter, Ronnie Shammas, et al., 2018).

The objective of the study of the scientists related to the health of the quality of life of patients with a cheekbone fracture was to assess the health related quality of life(HRQoL) before and after surgical treatment of a fracture of the zygomatic complex and to assess patients' perceptions of aesthetic and functional results of the operation. A prospective study of patients was conducted before and after surgery for fracture of the zygomatic complex. The HRQoL was measured using a universal 15-dimensional(15D) instrument, and patient satisfaction was assessed using an additional questionnaire. The average preoperative 15D score for patients was lower than for the general population, which was comparable in age and gender ($p = 0.011$). The average score of 15D was the lowest on the first postoperative day ($p < 0.001$) when patients had a worse score in 6 out of 15 measurements of the device, 15D in the general population during the first month after surgery. The loss of sensation of the infraorbital nerve(ION) at the end of a six-month follow-up was the single most important factor that tormented patients. The HRQoL score is significantly decreased after an injury, but improves several weeks after surgery, and the loss of sensation of the infraorbital nerve(ION) is a noticeable long-term factor that affects patients after a fracture of the zygomatic complex. When providing treatment, it must be borne in mind that the size of a fracture is directly related to the quality of life score, that is, loss of sensitivity [22].

CHAPTER 2
RESEARCH MATERIAL AND METHODS

To determine the state of the orbital floor in patients with injuries of the zygomatico-orbital complex(ZOC), we studied the medical history of patients treated in the Department of Oral and Maxillofacial Surgery of the 11th City Clinical Hospital in Minsk in the period of 2015-2017 years. 30 case histories of patients who had a clinical diagnosis of a fracture of the zygomatico-orbital complex(ZOC) with a displacement were analyzed with the aim of diagnosing CBCT. Upon admission, all patients underwent radiography in a half-axial projection, on the basis of which a diagnosis was made. To clarify the nature of displacement of fragments and determine the indications for the type of surgical treatment for patients, CBCT was performed. The research was conducted on a Galileos Viewer version 1.8, 2006-2011 Sirona Dental Systems GmbH, Software Engineering by SICAT by GmbH & Co. KG., matrix size 150 x 150 mm, Data Source: Galileos Implant version 1.8.

Of the 30 patients who entered the study, only 8 had a control CBCT. The remaining 22 to assess the quality of reduction was performed x-ray in half-axial projection. The study group consisted of 8 patients (7 men and 1 women). The age of patients ranged from 26 to 62 years. The longest observation time was one and a half years, and the shortest one was a week. All the patients were treated by open reduction of the ZOC and osteosynthesis with titanium mini-plates by subciliary, intraoral and access to the upper eyelid.

Patients were discharged from the hospital without complaints of visual impairment and other functional and aesthetic disorders. There is no clear data in the medical record of a hospital patient about ophthalmic disorders. Thus, the clinical result of treatment in all patients can be considered satisfactory.

The size and location of internal orbital defects, the displacement of soft tissues of the orbit, and the volume of the orbit were assessed in preoperative and postoperative CT. Sections were made in the ventrodorsal direction at 5.0 mm intervals on the front of the orbit-sinus, 10.0 mm on the middle part of the orbit-sinus and 10.0 mm on the back of the orbit-sinus, in the lateral plane on the both bony orbits(both on the orbital fracture and implant, and on the healthy one). Similar measurements were made in 8 patients with various dental problems. CBCT scans were recorded for the facial region of the skull containing the orbital region.

2.1. Comparative characteristic of x-ray methods for diagnosing injuries of the zygomatico-orbital complex

X-ray of the facial skull is carried out in two projections for patients with fractures of the ZOC, according to indications, spiral computed tomography with 3D reconstruction is used, stereolithographic models, a digital technology method, a projection method are created. If necessary, an ophthalmological examination is carried out, changes in the volume of the ocular orbit are calculated, lacrimation is examined (Malanchuk, V. A. et al., 2013), [29, p. 46–48]. A crucial role in the diagnosis of ZOC damage in Russian dentistry is played by a radiographic examination of the facial skull in a half-axial projection that allows to assess the state of the orbital floor, prolapse of the orbit contents and the air-liquid ratio in the maxillary sinus. Much more complete information about the severity of damage can be obtained using computed tomography(CT), which allows assessing the condition of both osseous and soft tissue structures. This is what allows us to state that today CT remains the main diagnostic method of choice to diagnose an orbital injury [44].

The measurement of orbital volume using CBCT was performed with patients undergoing enucleation and orbital implantation. According to Olga Lukats et al., today there is no suitable method to accurately measure bone orbit volume, which would be of particular importance in reconstructing orbital damage [31].

According to Pavlov O. M. [34], MSCT in a craniomaxillofacial trauma allows to accurately and quickly make a diagnosis and reduces the total time of research. But the presence of unstable hemodynamics, ongoing bleeding, respiratory failure may require intubation, mechanical ventilation, thoracostomy, arrest of heavy bleeding before performing MSCT [Pavlov O. M., 2017].

The use of the 3D modeling results during MSCT can facilitate the understanding of the nature and extent of surgical procedures, and also simplifies the preparation for the surgical stage of treatment [Pavlov, O. M., 2017].

For correct and timely diagnosis (specifically for clinical use), it is necessary to anatomically justify the following: a) injuries involving the zygomatic bone in fractures of the zygomatic bone only, b) fractures that cause damage to the bones and soft tissue contents of the orbit, c) fractures in which the upper jaw is damaged. It is necessary to provide clear rationale for the choice of mandatory methods for examining patients with fractures of the zygomatico-orbital complex(ZOC) in order to define the state of the orbital floor in a fracture of the zygomatico-orbital complex(ZOC) [Pavlov, O. M., 2017]. The use of the capabilities of radiological methods for this type of damage facilitates the clinical application of modern diagnostic methods [Pavlov, O. M., 2017].

In the study conducted by Candace Y. Pau et al. [56], a new method for assessing a fracture of the ZOC is introduced, which uses the three-dimensional(3D) imaging method to visualize and quantify the displacement of the malar eminence(ME) in the anteroposterior, medial-lateral and upper-lower dimensions. Then, the nature of displacement correlates with the recommended intervention, representing a clinical assessment of treating the severity of a fracture, as well as the possible outcome [56].

The use of MSCT to assess the correlation of the nature of a fracture with the result of treatment can be seen in the work of Candace Y. Pau et al., 2010. Facial MSCTs were obtained by Candace Y. Pau et al., from patients with unilateral fractures of the zygomatico-maxillary complex(ZMC) and patients without fractures and analyzed. The displacement of the malar eminence(ME) on the broken side was determined in the medial-lateral, upper-lower and anteroposterior measurements, as well as the Euclidean distance compared to the malar eminence(ME), which is located on the inextricable side. The initial natural variance of asymmetry was taken into account by comparing the location of the malar eminence(ME) on the left and right of subjects without fractures. Thus, the determination of the nature of a fracture of the ZOC can be informative when considering treatment options [56].

In all patients included in their own study, the analysis of radiographs in a half-axial projection was performed. When examining of X-ray patterns, the displacement of fragments(step deformity) along the lower margin of the orbit was determined. However, this fact cannot be a reliable criterion for assessing the presence of a fracture of the orbital floor in all sections and the displacement of fragments. First, it is relatively reliable to estimate a fracture of the lower margin of the orbit (the junction of the orbital floor to the anterior surface of the upper jaw in the region of the anterior wall of the maxillary sinus). Indirectly about the presence of displacement in the anterior part of the orbital floor. Secondly, taking into account the setup characteristics (the position of the patient's head relative to the x-ray – the frontal plane of the orbit is at an angle to the direction of the beam), it is impossible to reliably determine in absolute numbers the displacement of fragments in the region of the lower orbital margin and, accordingly, to evaluate the real value of the displacement of fragments of the orbital floor.

Thus, considering the data from literature analysis and our own studies of X-ray patterns in a half-axial projection, it becomes obvious that either MSCT or CBCT is necessary to determine the state of the orbital floor. These methods have common features, pros and cons.

The condition for obtaining reliable data on the state of the orbital walls in a fracture of the ZOC is an indicator of the matrix size of the CBCT apparatus. To obtain an informative result, the matrix size should be at least 150 x 150 mm, which allows capturing bones of the midface and the orbit together with the roof, which serves as a guideline along with the main bone for measuring linear dimensions and orbit volume. In the Republic of Belarus at the moment, there are devices for CBCT with the specified characteristics, namely, Sirona Dental Systems GmbH with Software Engineering by SICAT by GmbH & Co. KG and Planmeca ProMax 3D Max (Plus, Mid), Planmeca Oy with Planmeca Romexis software. CBCT allows us to quickly obtain an image of the region of interest with 3 main planes with the possibility of 3D imaging with high resolution, without limiting the patient's mass with minimal radiation exposure. Limitations for performing CBCT may be as follows: combined injury (for example, CCT), damage to the musculoskeletal system.

2.2. Method for determining the state of the orbital floor using cone beam computed tomography

For example, the Hungarian Dental School uses the CBCT method using the Cranioviewer program, a control procedure that compares the patient's preoperative and postoperative X-ray patterns, a digital technology method that calculates the distance of fractures of the zygomatico-orbital complex(ZOC) [31]. The use of these procedures in combination is characteristic of measuring the orbital volume after enucleation and orbital implantation. The longest observation time was 7 years, and the shortest one was 1 year. The orbit volume was measured using Cranioviewer software. Sections were made in the ventrodorsal direction with 4.8 mm intervals in the frontal plane on both bony orbits(both on the orbital implant and on the healthy one). Similar measurements were made in patients with various dental problems. The Cranioviewer program can color the section region in red and it automatically measures the area in mm. According to Olga Lukats et al., today there is no suitable method to accurately measure bone orbit volume, which would be of particular importance in reconstructing orbital damage [31]. Nevertheless, using the results of CBCT images and Cranioviewer orbital software (the Cranioviewer program can color the section region in red and it automatically measures the area in mm) is a reliable method for measuring changes in orbital volume.

The size and location of internal orbital defects, the displacement of soft tissues of the orbit, and the volume of the orbit were assessed in preoperative and postoperative CT. Based on literature data, we investigated the linear dimensions of localization of the orbital floor in three sections(anterior, medial, and posterior) in the sagittal plane, as one of the parameters determining the degree of displacement of fragments. The reference points of choice for the sagittal plane were the infraorbital foramen and the middle of the alveolar process in the region of the first molar. Sections were made in the ventrodorsal direction at 5.0 mm intervals on the front of the orbit-sinus, 10.0 mm on the middle part of the orbit-sinus and 10.0 mm on the back of the orbit-sinus, in the lateral plane on the both bony orbits(both on the side of a ZOC fracture, and on the healthy one). Similar measurements were made in 8 patients who had initial and control CBCTs, of sufficient quality, with the possibility of landmarks of the floor, roof of the orbit and alveolar process of the upper jaw. CBCT scans were recorded for the facial region of the skull containing the orbital region. In the remaining 22 patients, only the initial CBCT data was studied, since either the control CBCT (postoperative) was absent or their quality did not permit the estimation of the linear dimensions by using the above method, which was due to the low focusing of the device matrix or the image was unclear due to the error of the procedure.

The depth of the orbital floor was determined in the above plane – from the orbital surface of the main bone to below the front edge of the orbit on the healthy intact side.

The measurement marks were 5 mm proximal to the lower margin of the orbit with a distance of 10 mm. The measurements were performed perpendicular to the line of the orbital floor up to the cortical plate of the frontal bone, down to the cortical plate of the inner surface of the alveolar opening. If the line reached the root of the tooth, the measurement was carried out before the projection of the cortical plate in the region of interdental spaces (Fig.1).

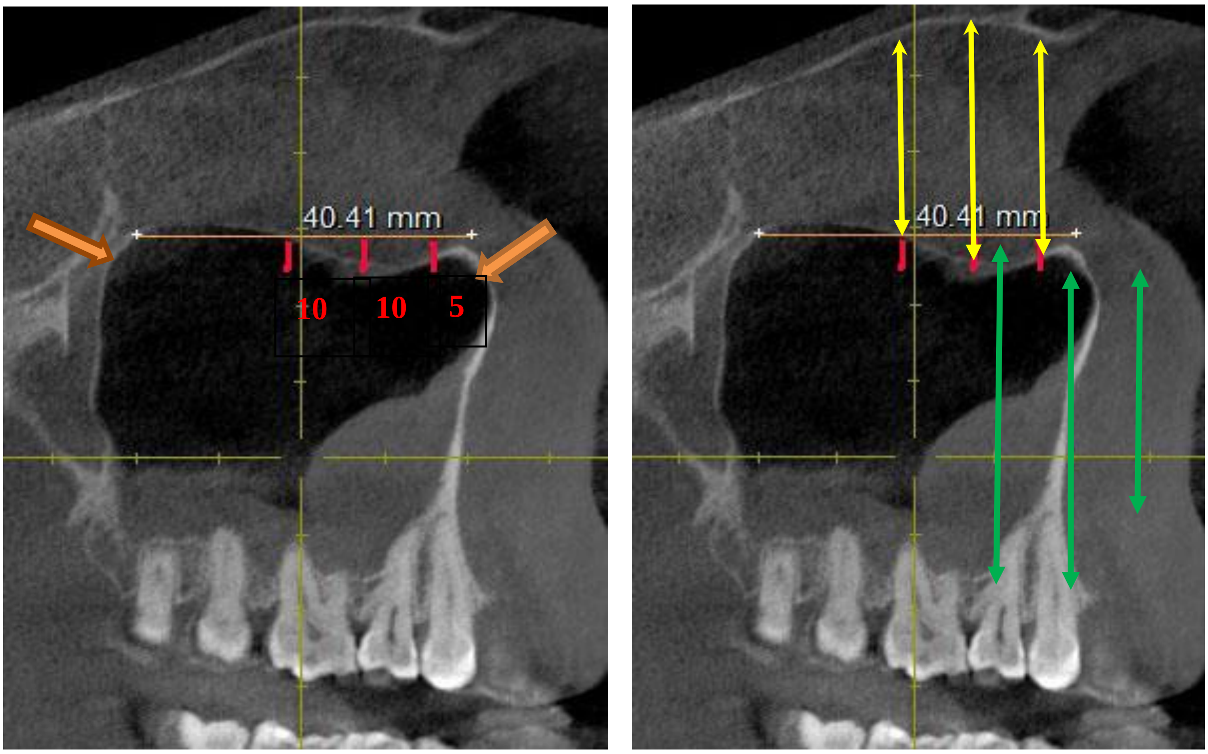

Fig.1. Scheme for determining the linear dimensions of the Orbit-Sinus

CHAPTER 3
CHARACTERISTIC OF DAMAGES TO THE ORBITAL FLOOR

3.1. Preoperative state of the orbital floor in fractures of the zygomatico-orbital complex

Here are some examples of the study. Patient Sh. A. A., a 30-year-old man with a fracture of the naso-orbital complex on the left, reduced fragments of the naso-orbital complex on the left and osteosynthesis of the naso-orbital complex on the left performed using a titanium mesh plate. Under endotracheal anesthesia with a subciliary approach, an incision was made in the region of the lower eyelid on the left with a size of up to 2.0 cm, the mucoperiosteal flap was peeled off. The bones are skeletonized in the region of the fracture line. A comminuted fracture of the naso-orbital complex on the left was identified, the fragments were reduced to a physiologically correct position. They were fixed on the front surface with a titanium mesh plate on 4 screws. Intraoperative hemostasis. The wound was washed with antiseptic solutions. The mucoperiosteal flap is laid in place, fixed with interrupted stitches PHA 3/0.

The depth of the orbital floor was 40.41 mm and the size of the fracture before surgery on February 7, 2017, which was CBCT captured by the patient on the healthy side in front of the Orbit-Sinus was 29.99-37.11 mm, in the middle of the Orbit-Sinus it was 30.75-43.21 mm and on the back of the Orbit-Sinus it was 29.99-37.78 mm. And, on the damaged side (left) on the front of the Orbit-Sinus it was 37.78-33.04 mm, on the middle of the Orbit-Sinus it was 36.09-38.38 mm and on the back of the Orbit-Sinus it was 33.30-30.75 mm.

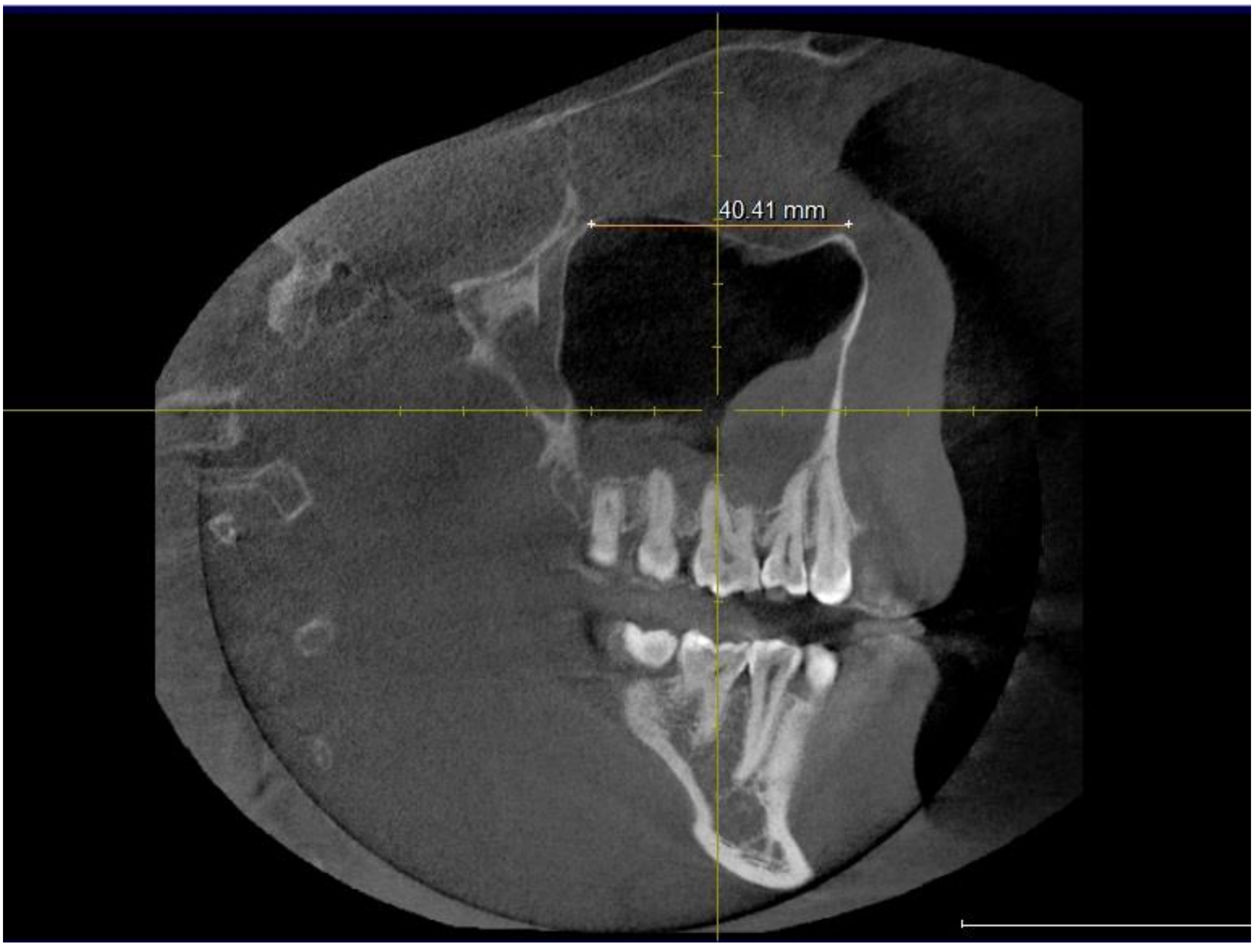

Fig.2. Patient Sh. A. A. Depth of the orbital floor, mm, healthy side

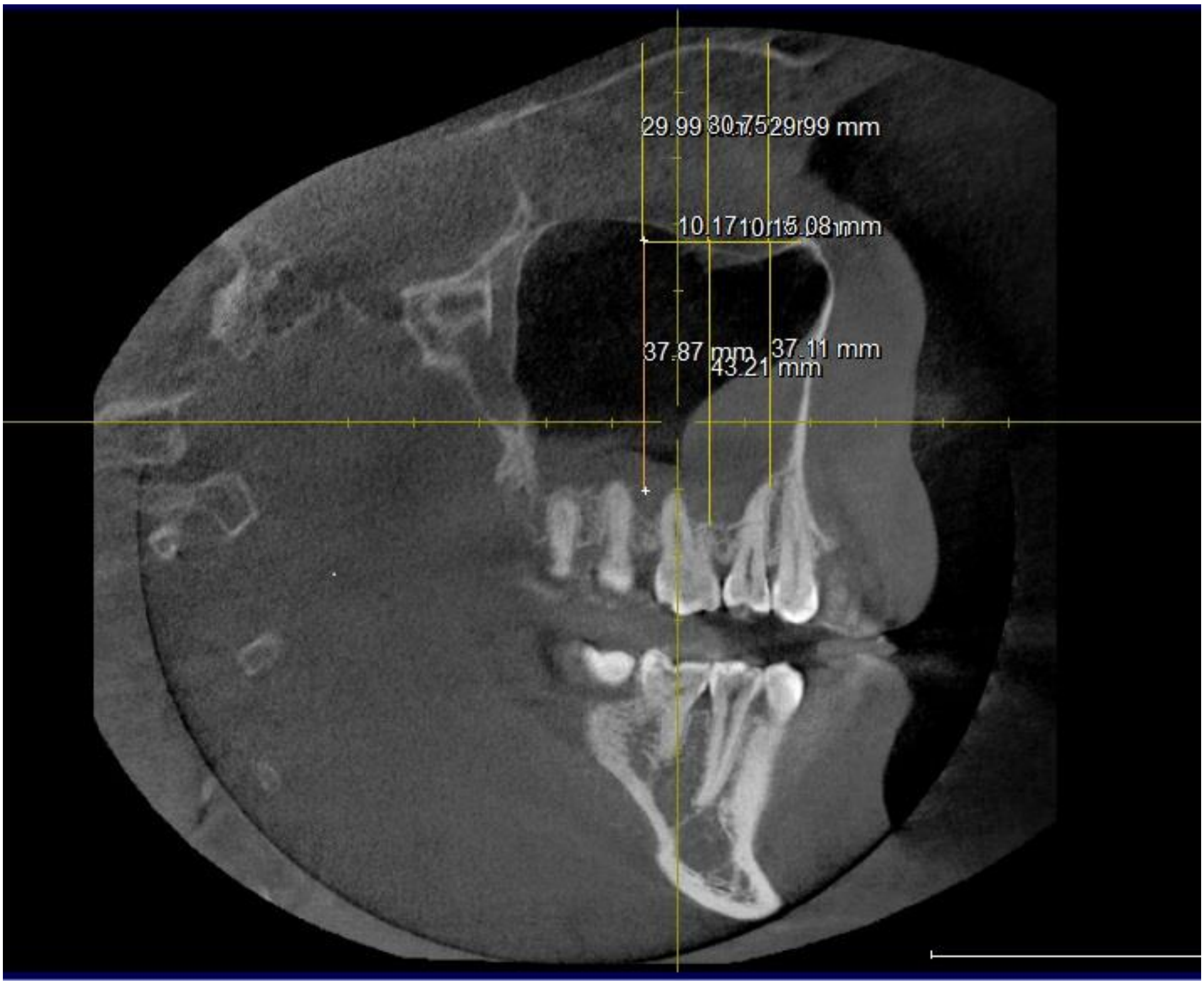

Fig.3. Patient Sh. A. A. Distance of the anterior, medial and posterior sections of the Orbit-Sinus, mm, healthy side, before surgery

Fig.4. Patient Sh. A. A. Depth of the orbital floor, mm, damaged side, before surgery

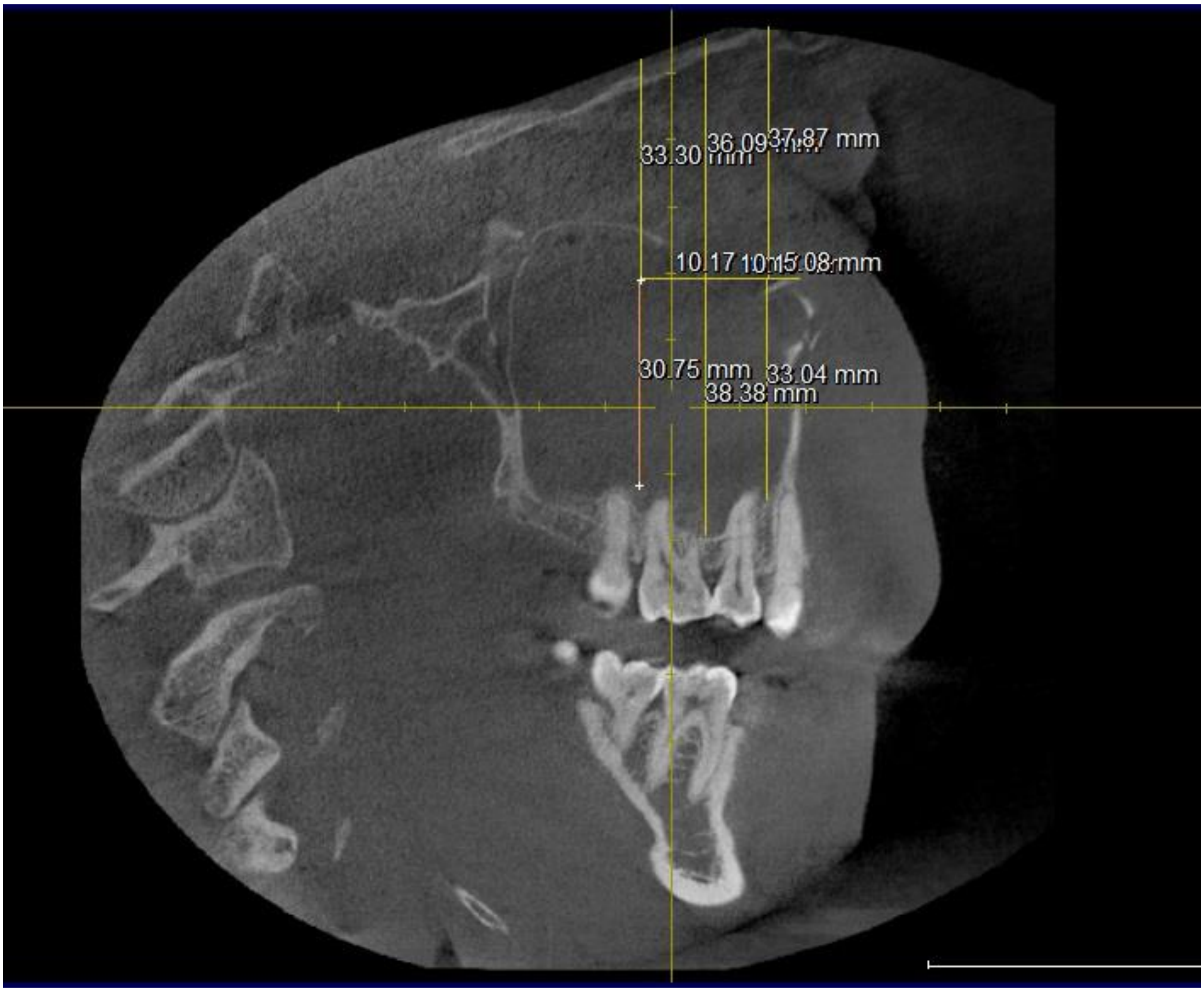

Fig.5. Patient Sh. A. A. Distance of the anterior, medial and posterior sections of the Orbit-Sinus, mm, damaged side, before surgery

Fig.6. Patient L. A. A. Depth of the orbital floor, mm, healthy side, before surgery

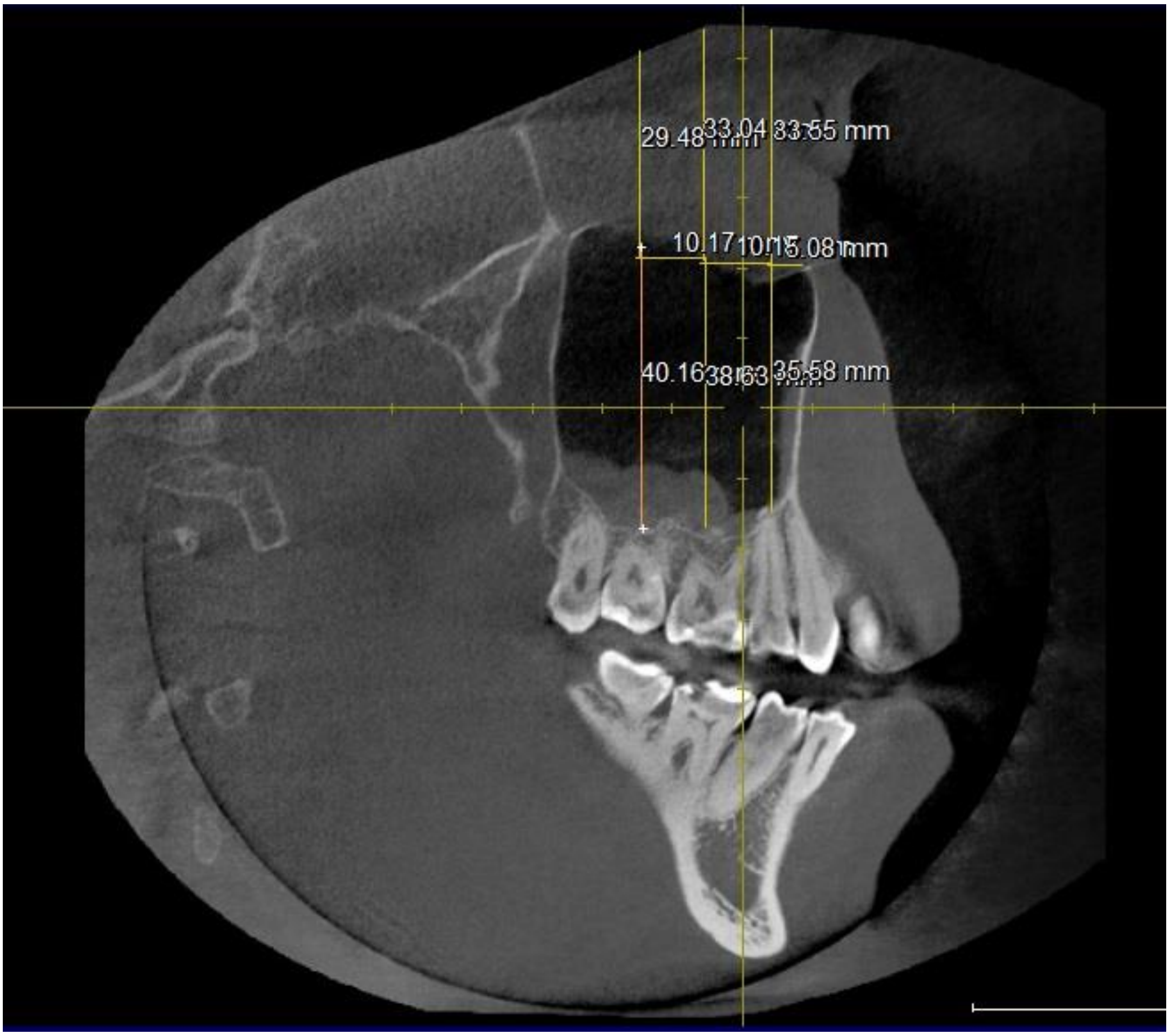

Fig.7. Patient L. A. A. Distance of the anterior, medial and posterior sections of the Orbit-Sinus, mm, healthy side, before surgery

Fig.8. Patient L. A. A. Depth of the orbital floor, mm, damaged side, before surgery

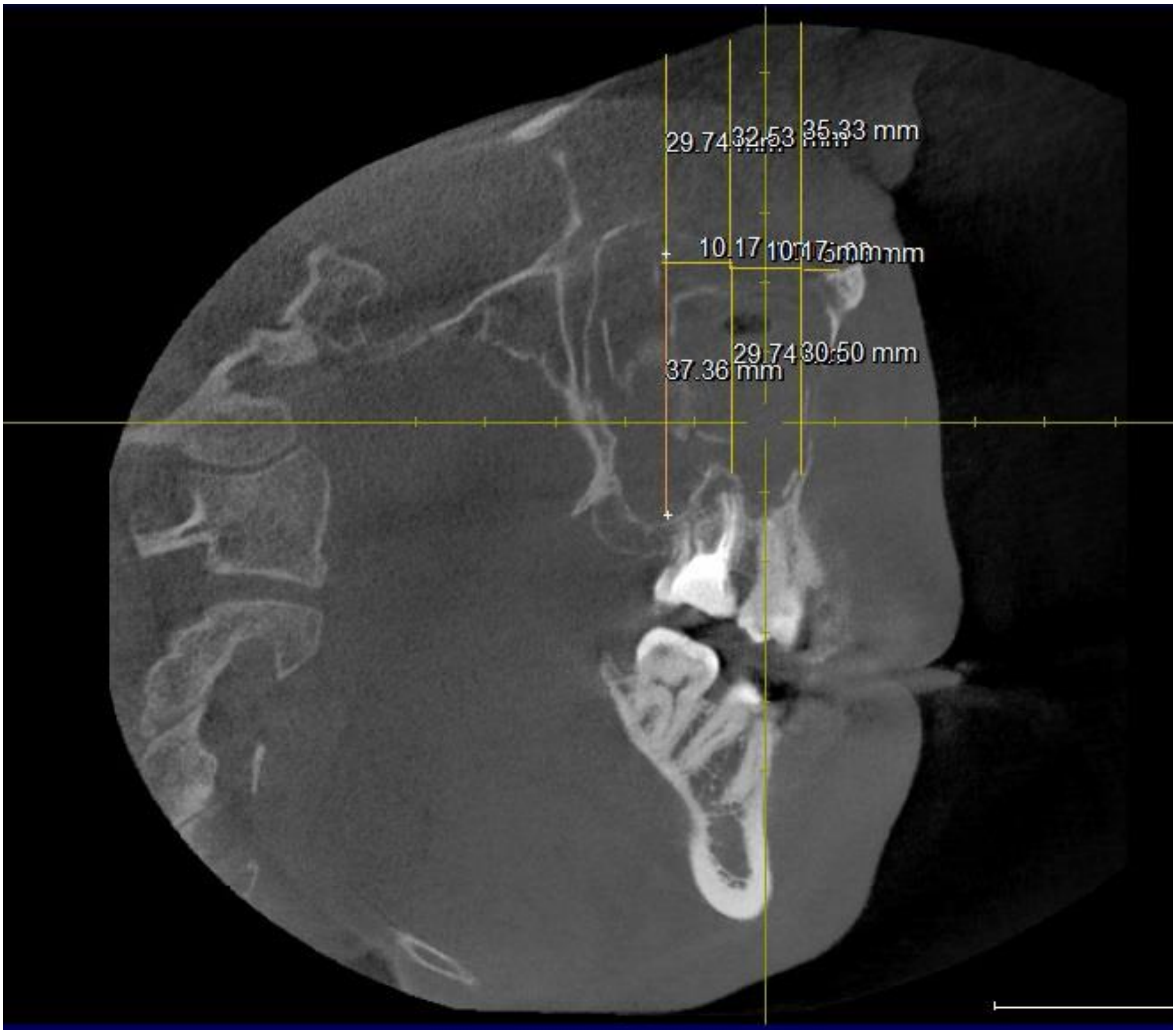

Fig.9. Patient L. A. A. Distance of the anterior, medial and posterior sections of the Orbit-Sinus, mm, damaged side, before surgery

Table 1

Preoperative orbital volume measurement

Patient No	Surname, Name, Middle Name	Orbital Floor Depth, mm	Healthy Side			Damaged side		
			Anterior Part Distance, mm (Orbit-Sinus)	Medial Part Distance, mm (Orbit-Sinus)	Posterior Part Distance, mm (Orbit-Sinus)	Anterior Part Distance, mm (Orbit-Sinus)	Medial Part Distance, mm, (Orbit-Sinus)	Posterior Part Distance, mm, (Orbit-Sinus)
1	Alexey Aleksandrovich Shakhray	40.41	29.99-37.11	30.75-43.21	29.99-37.78	37.78-33.04	36.09-38.38	33.30-30.75
2	Anatoly Vladimirovich Gridasov	38.38	33.55-25.42	34.31-40.67	33.04-41.68	38.63-36.09	39.14-36.35	36.35-34.57
3	Dmitry Sergeyevich Gridiushkov	37.36	34.31-27.96	34.82-35.08	29.48-39.40	38.89-32.79	38.38-32.53	33.80-27.45
4	Denis Alekseyevich Bavtuto	37.36	43.21-18.81	37.36-27.96	33.80-26.18	43.21-21.60	39.14-31.77	37.62-31.01
5	Alexander Antonovich Litvinovich	35.58	33.55-35.58	33.04-38.63	29.48-40.16	35.33-30.50	32.53-29.74	29.74-37.36
6	Anastasia Eduardovna Kravchenko	37.87	45.50-18.30	46.00-25.92	41.43-29.99	44.73-15.25	44.22-27.45	42.95-32.28
7	Nikolay Nikolayevich Birilo	39.90	42.95-23.64	38.89-41.18	36.35-41.43	38.63-31.52	38.89-38.38	36.35-38.13
8	Ilya Vikentievich Zenevich	31.01	32.28-17.03	33.30-30.75	28.72-31.26	35.84-23.38	34.06-28.97	30.50-31.01

3.2. Postoperative state of the orbital wall in fractures of the zygomatico-orbital complex

Here is a clinical example of postoperative evaluation of the result of an open reduction of the ZOC. After the surgery on February 16, 2017, CBCT was repeatedly carried out to patient Sh. A. A. We measured the linear dimensions of the Orbit-Sinus using the Galileos Viewer version 1.8, 2006-2011 program Sirona Dental Systems GmbH, Software Engineering by SICAT by GmbH & Co. KG., Data Source: Galileos Implant version 1.8. According to the method described above, similarly to the preoperative research. It was found that there were no changes on the healthy side, and on the damaged side (left) on the front the Orbit-Sinus was 39.40-17.28 mm, respectively, on the middle part the Orbit-Sinus was 36.85-34.06 mm and on the back, the Orbit-Sinus was 34.06-35.33 mm (Fig.10,11).

According to the examination entries of attending physicians in the inpatient card, the postoperative period was without complications, and the patient was discharged without complaints of visual impairment and with no signs of enophthalmos, diplopia and eye movement disorder.

Thus, the displacement of fragments of the orbital floor after reduction and the difference in the linear vertical dimensions of the orbit from the damaged side and the healthy one were preserved. The surgical intervention did not lead to a complete restoration of the spatial position of the orbital floor, although this fact did not lead to an ophthalmic disorder.

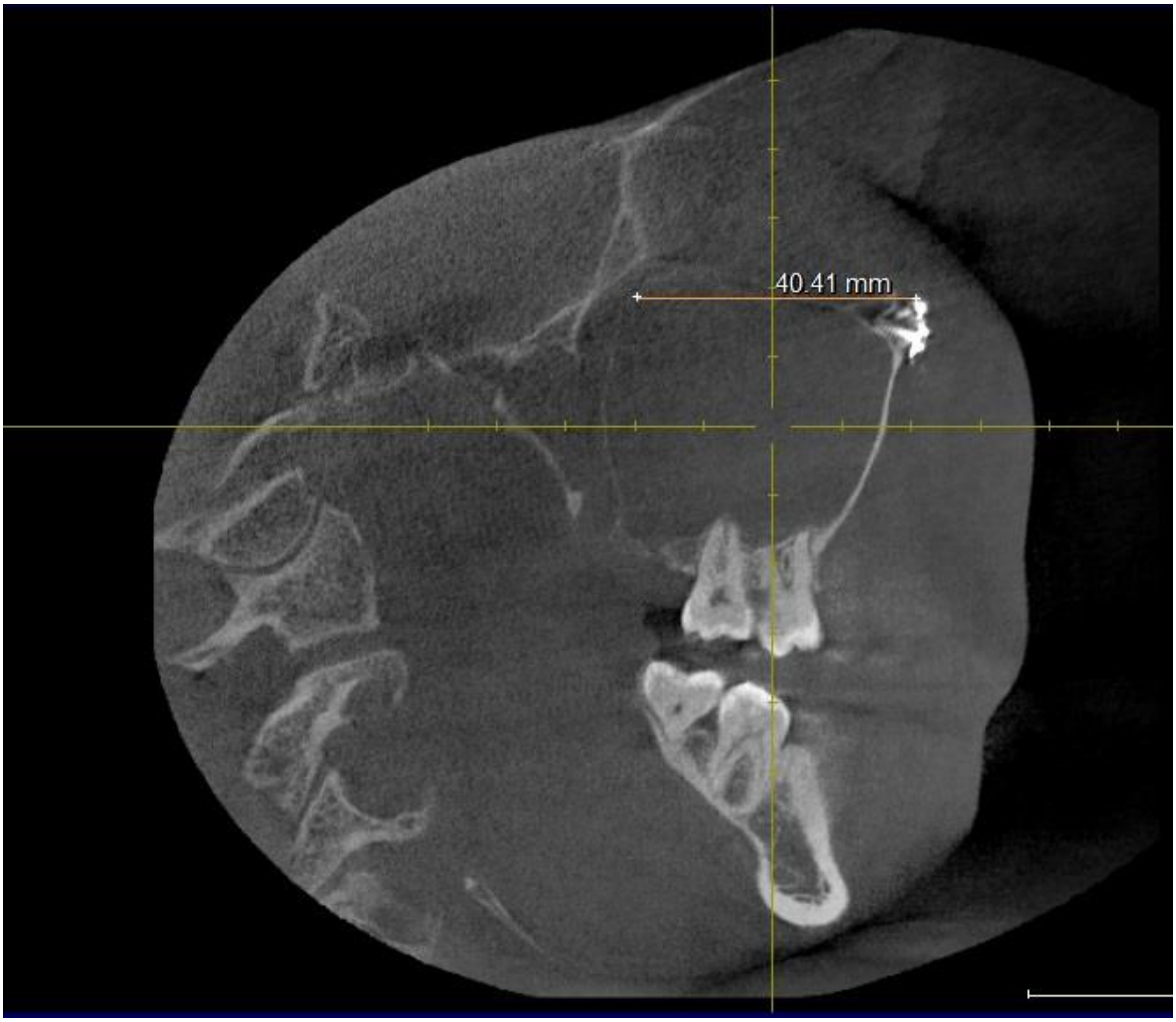

Fig.10. Patient Sh. A. A. Depth of the orbital floor, mm, damaged side, after surgery

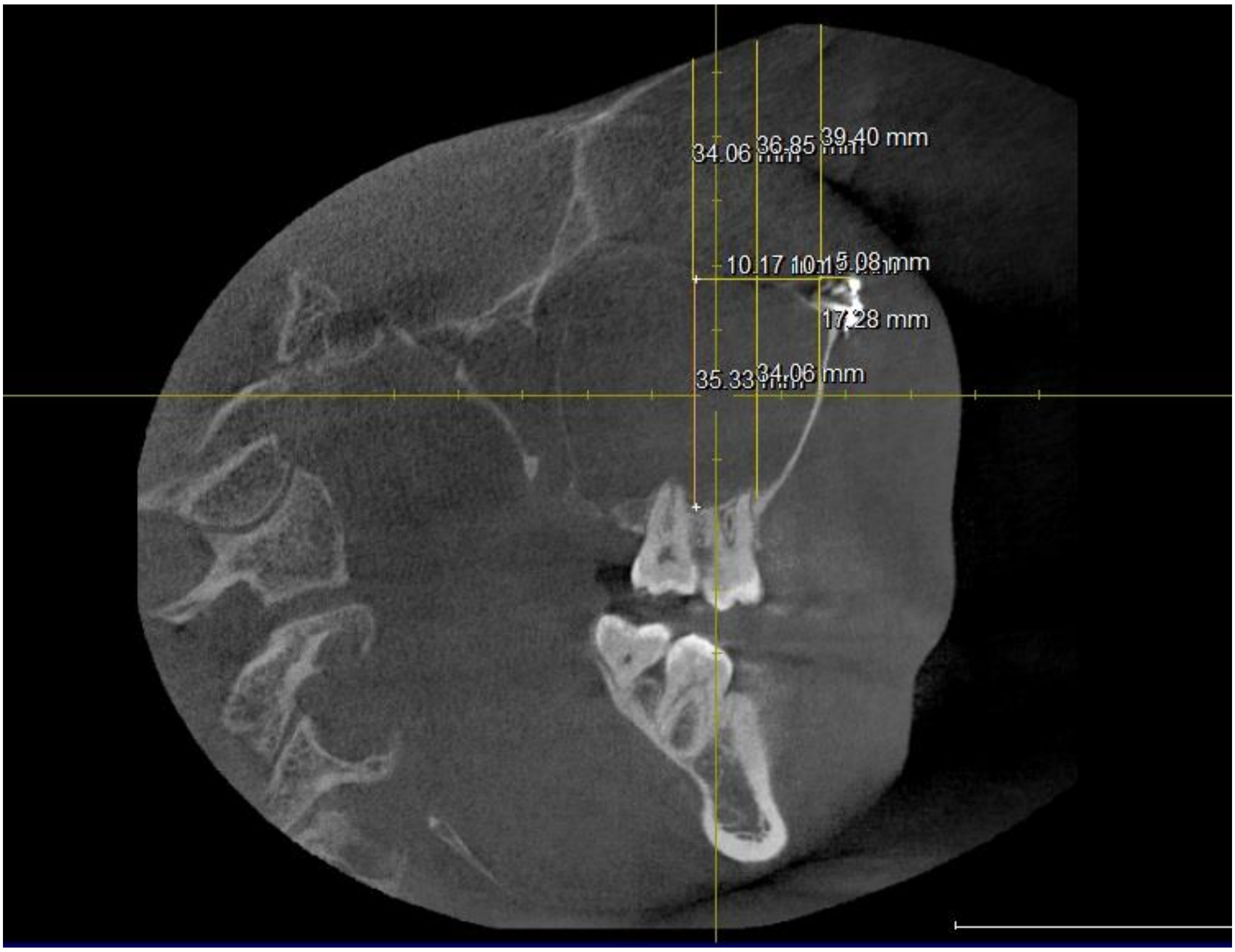

Fig.11. Patient Sh. A. A. Distance of the anterior, medial and posterior sections of the Orbit-Sinus, mm, damaged side, after surgery

Patient L. A. A., a 29 years old man with a fracture of the ZOC on the left, a fracture of the frontal process of the upper jaw on the left, neuropathy of the II nerve branch on the left. The patient underwent open osteosynthesis of midface bones: open reduction and osteosynthesis of the zygomatico-orbital complex(ZOC) on the left, frontal process of the upper jaw on the left. Under anesthesia, a point incision was made under the body of the zygomatic bone, a Limberg's hook was inserted into the wound, the fragments were reduced to the anatomically correct position, there is a secondary displacement.

A linear incision was made along the lower crease of the upper eyelid. The skin, the orbicular muscle of the eye, the periosteal coverage are dissected in layers. A fracture line was skeletonized in the region of the zygomatico-frontal suture. The fracture line was fixed with a C-shaped mini-plate on 4 screws. Hemostasis. Layer-by-layer sutures of a wound.

A linear incision was made along the oral vestibule from tooth 21 to tooth 24. The fracture line is skeletonized. The frontal process of the upper jaw on the left was reduced to the anatomically correct position. Fixation carried out by a linear mini-plate on 4 screws. Hemostasis, sutures of a wound. Skin closure. A turunda was inserted into the left half of the nose, a plaster bandage was applied to the nose.

After the surgery, CBCT was carried out again. We measured the linear dimensions of the Orbit-Sinus according to the method described above, similarly to the preoperative research. It was found that on the damaged side (left) along the front the Orbit-Sinus was 34.17-34.28 mm, respectively, in the middle part the Orbit-Sinus was 35.66-37.31 mm and on the back the Orbit-Sinus was 30.37-38.70 mm (Fig.12,13).

According to the examination entries of attending physicians in the inpatient card, the postoperative period was without complications, and the patient was discharged without complaints of visual impairment and with no signs of enophthalmos, diplopia and eye movement disorder.

Thus, the displacement of fragments of the orbital floor after reduction and the difference in the linear vertical dimensions of the orbit from the damaged side and the healthy one were preserved. The surgical intervention did not lead to a complete restoration of the spatial position of the orbital floor, although this fact did not lead to an ophthalmic disorder.

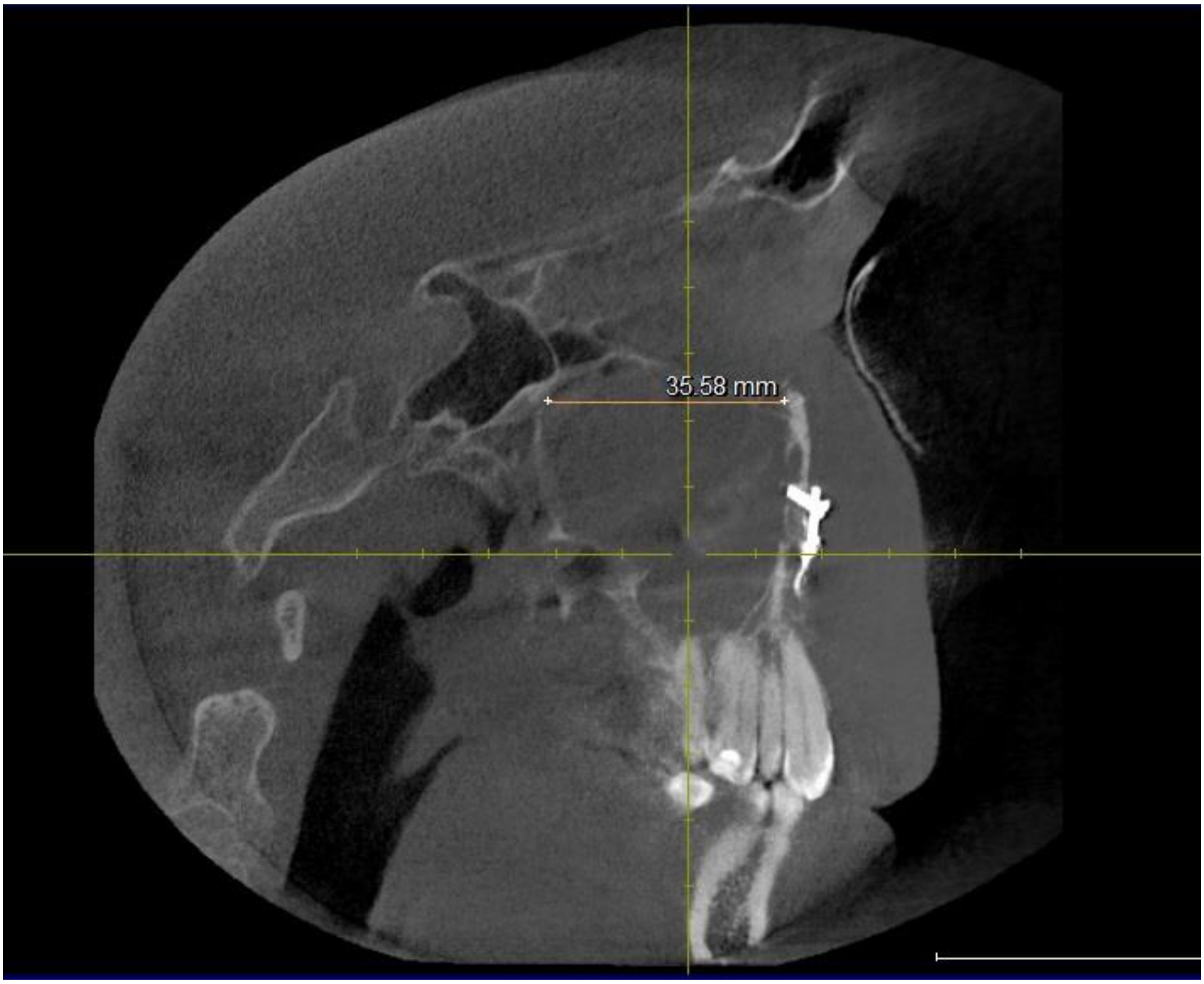

Fig.12. Patient L. A. A. Depth of the orbital floor, mm, damaged side, after surgery

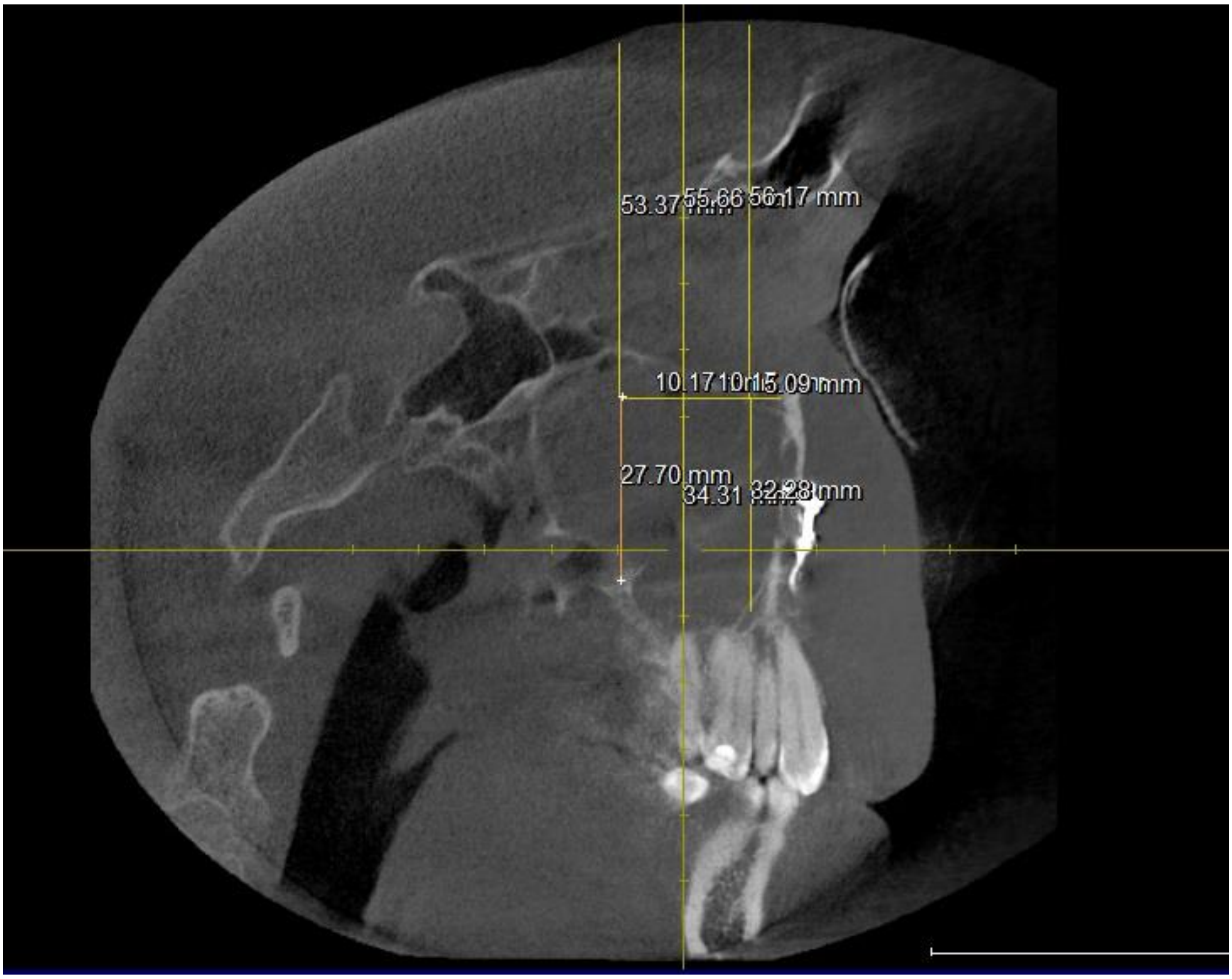

Fig.13. Patient L. A. A. Distance of the anterior, medial and posterior sections of the Orbit-Sinus, mm, damaged side, after surgery

Table 2

Postoperative measurement of the orbital volume

Patient No	Surname, Name, Middle Name	Orbital Floor Depth, mm	Healthy Side			Damaged side		
			Anterior Part Distance, mm (Orbit-Sinus)	Medial Part Distance, mm (Orbit-Sinus)	Posterior Part Distance, mm (Orbit-Sinus)	Anterior Part Distance, mm, (Orbit-Sinus)	Medial Part Distance, mm, (Orbit-Sinus)	Posterior Part Distance, mm, (Orbit-Sinus)
1	Alexey Aleksandrovich Shakhray	40.41	29.99-37.11	30.75-43.21	29.99-37.78	39.40-37.28	36.85-34.06	34.06-35.33
2	Anatoly Vladimirovich Gridasov	38.38	33.55-25.42	34.31-40.67	33.04-41.68	34.31-26.94	33.80-38.13	31.77-37.36
3	Dmitry Sergeyevich Gridiushkov	37.36	34.31-27.96	34.82-35.08	29.48-39.40	38.63-34.06	39.14-31.26	36.35-28.47
4	Denis Alekseyevich Bavtuto	37.36	43.21-18.81	37.36-27.96	33.80-26.18	45.24-21.61	42.70-32.28	36.85-32.79
5	Alexander Antonovich Litvinovich	35.58	33.55-35.58	33.04-38.63	29.48-40.16	34.17-34.28	35.66-37.31	30.37-38.70
6	Anastasia Eduardovna Kravchenko	37.87	45.50-18.30	46.00-25.92	41.43-29.99	44.22-19.82	45.24-31.77	42.95-31.77
7	Nikolay Nikolayevich Birilo	39.90	42.95-23.64	38.89-41.18	36.35-41.43	44.22-43.97	44.73-45.24	42.95-40.92
8	Ilya Vikentievich Zenevich	31.01	32.28-17.03	33.30-30.75	28.72-31.26	34.31-25.93	33.55-28.21	28.98-28.21

Based on the results of the study, all the 8 patients showed that the volume of a surgically operated orbit was significantly larger than the volume of a healthy orbit and the results can be considered to be a decrease in the orbital floor in fractures of the ZOC in all the patients. The size of internal orbital defects decreased slightly with an increase in the vertical size of the maxillary sinus. But internal orbital fractures were rebuilt, and only a few had an increase in orbital volume or sagging soft tissues in the sinuses. An examination of subsequent CT scans in several patients taken from several weeks to several months showed that residual defects became smaller and that none of these patients had an increase in orbit volume or sagging soft tissues.

Our studies correlate with the study (Xiang-Zhen Liu et al., 2013), where an attempt was made to present 3D virtual surgical planning and digital rapid prototyping(RP) templates for zygomatico-maxillary complex(ZMC) injuries associated with changes in orbital volume, and to quantify the results of surgical interventions.

CT-scanning of the ZOC was carried out preoperatively in each case. Scanned data was converted into 3D models using Mimics software(Materialize, Brussels, Belgium) for surgical designs. Operations were performed using ready-made templates to reduce fractures. Postoperative computed tomography(CT) of each patient was obtained within 2 weeks postoperatively, followed by quantitative measurements to evaluate the results of the operation. Preoperative volumes of bilateral orbits were compared and evaluated in accordance with postoperative volumes of bilateral orbits. Twenty-one pairs of distances from 7 markers to 3 base planes were measured to assess postoperative facial symmetry.

The results showed that the volumes of damaged orbits significantly differed from the volumes of undamaged orbits before surgery ($P < 0.05$), while bilateral orbital volumes did not show a statistically significant difference in the postoperative period ($P > 0.05$).

Therefore, the presence of postoperative displacement of fragments of the orbital floor does not necessarily lead to the development of diplopia or enophthalmos.

CONCLUSION

All of the above allows concluding that CBCT can be used to assess internal orbit abnormalities in order to develop a treatment plan for patients with fractures of the ZOC. CBCT allows to obtain data on the structure of the orbital walls and the maxillary sinus, provides imaging of osseous structures of the upper jaw, zygomatic bone and orbit in case of fractures of the ZOC.

The main condition for the effective use of CBCT to assess the orbital walls in fractures of the zygomatico-orbital complex(ZOC) is the matrix size and focusing an object on it. Using Sirona CBCT apparatus and Galileos Viewer version 1.8 software Dental Systems GmbH, Software Engineering by SICAT by GmbH & Co. KG. offers a reliable method for measuring changes in orbital volume.

All the 30 patients included in the research revealed the solution of continuity of the orbital floor and dislocation of fragments in the sagittal plane downward, an increase in the vertical linear dimensions of the orbit and, accordingly, a decrease in the vertical linear dimensions of the sinus.

In 8 patients, after reducing the zygomatico-orbital complex(ZOC) and trans-focal osteosynthesis, dislocation of fragments of the orbital floor was preserved according to postoperative CBCT data. However, the presence of a dislocation of the orbital floor did not lead to pronounced clinical complications and consequences.

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