СЛУЧАЙ ИЗ ПРАКТИКИ

# THE EFFECTIVENESS OF ORBITAL VOLUMES CALCULATIONS AFTER TRAUMATIC INJURIES BASED ON CT DATA

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To present a case of a 56 y.o. male with maxillo-facial trauma after falling from heights and the possibility to choice the treatment tactics based on CT volume calculation.

**Material and methods.** Patient N., 56 years old, came to the clinic 3 days after the injury – a fall from heights. During the examination in the clinic, the patient did not have visual impairments and difficulties in eye movement. We performed MSCT of the maxillofacial region, which revealed radiological signs of fractures of the lower and lateral walls of the right orbit. In order to determine further treatment tactics for this patient (surgical treatment or conservative therapy), the authors performed additional processing of MSCT data in order to obtain clarifying diagnostic information.

**Results.** The authors performed the calculation of orbital volumes and confirmed the possible minimal risk of post-traumatic complications such as enophthalmos and hypophthalmos. It was decided to treat the patient conservatively. The long-term follow-up MSCT study confirmed the correct management of a patient with orbital trauma in terms of restoration of the right orbit walls with minimal volumetric change.

**Conclusion.** This case highlights the advantage of using new techniques of CT data processing in daily practice.

Keywords: MSCT, CT data postprocessing, enophthalmos, orbital volume.

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# ЭФФЕКТИВНОСТЬ ИЗМЕРЕНИЙ ОБЪЁМОВ ОРБИТ ПРИ ТРАВМАТИЧЕСКИХ ПОВРЕЖДЕНИЯХ СРЕДНЕЙ ЗОНЫ ЛИЦА ПО ДАННЫМ КОМПЬЮТЕРНОЙ ТОМОГРАФИИ

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Представить клиническое наблюдение пациента 56 лет, получившего травму после падения с высоты, и определить возможность выбора тактики лечения пациента на основе КТ-расчётов объёмов орбит.

**Материалы и методы.** Пациент Н., 56 лет, обратился в клинику через 3 суток после травмы – падения с высоты. При обследовании в клинике у пациента не наблюдалось нарушений зрения и затруднения движения глазного яблока. Нами была выполнена МСКТ челюстно-лицевой области, на которой были выявлены рентгенологические признаки переломов нижней и наружной стенок правой орбиты. С целью определения дальнейшей тактики лечения этого пациента (оперативное лечение или консервативная терапия) авторами была выполнена дополнительная обработка данных МСКТ с целью получения уточняющей диагностической информации.

**Результаты.** Авторы выполнили расчет орбитальных объемов и подтвердили возможный минимальный риск посттравматических осложнений, таких как энофтальм и гипофтальм. Было принято решение провести консервативное лечение паци-

ента. Выполнение МСКТ исследования в отдаленном периоде наблюдения подтвердило верную тактику ведения пациента с травмой орбиты в вопросе восстановления стенок правой орбиты с ее минимальным объемным изменением.

**Выводы.** Данный клинический случай подчеркивает преимущество использования новых методов обработки данных компьютерной томографии в повседневной клинической практике.

Ключевые слова: МСКТ, обработка КТ данных, энофтальм, объемы орбиты.

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**Introduction.**

Nowadays the problem of orbital trauma is still relevant worldwide [1, 2, 4]. Levels of domestic violence during the COVID-19 pandemic increased globally, in some cases, leading to maxilla-facial trauma [3]. Since orbital trauma frequently results in persistent aesthetic and functional impairment, the correct diagnosis is essential for precise preoperative planning [2, 4, 6]. At the same time current diagnostics must be as objective as possible in order to avoid unnecessary surgical treatment and possible postoperative complications [2, 4, 6].

MSCT is a well-known standard for orbital trauma visualization [2, 4]. However, there is still a possibility of subjective assessment and misinterpretation of CT data with a “naked eye”. Therefore, it is critically important to use new techniques of CT data processing in daily practice to be able to get precise information about patient’s condition.

Fig. 1 (Рис. 1)

**Fig. 1. Photo.**

View of the patient N. 48 hours after the trauma (the agreement of the patient and the ethics committee for the photo was obtained).

**Рис. 1. Фото.**

Внешний вид пациента Н. через 48 часов после травмы (согласие пациента и этического комитета на фотографию получены).

**Case presentation.**

Patient N, male, 56 years old, was presented to the maxilla-facial hospital of Sechenov University after falling from the roof of the two-storey building. The patient had complaints of face swelling and hematomas on the right side of the face. During the clinical examination, changed facial configuration and increased right paraorbital area due to soft tissue edema was deter-mined, as well as skin abrasions, hematomas in the upper and lower eyelids, narrowing of the right ocular gap, numbness of the infraorbital region (Fig. 1). He had no visual or orbital movement impairment.

The patient underwent skull CT which revealed fractures of the right zigomatico-orbital complex including inferior orbital wall (Fig. 2).

Patient’s condition was consulted with 3 maxillo-facial surgeons about further treatment tactic. One of them was planning to operate on him using inferior orbital wall prosthetic and metallic osteosyntesis in the midface, the other two surgeons were unsure about the necessity of surgical treatment and recommended dynamic follow-up.

In order to get additional diagnostic information and objectify the assessment of CT data,

Fig. 2 a (Рис. 2 а)

Fig. 2 b (Рис. 2 б)

**Fig. 2. MSCT, bone window.**

a – coronal view, b – axial view. Coronal computed tomography image in early posttraumatic period, fracture in the inferior orbital wall on the left, as well lateral orbital wall and maxillary sinus wall.

**Рис. 2. МСКТ, режим костной плотности.**

а – корональная проекция, б – аксиальная проекция. Визуализируются переломы нижней и латеральной стенок правой орбиты.

we performed measurements of orbital volumes. For measurement of orbital volumes the bone borders of the orbits were marked on every axial slice using an “ellipse” toll on the workstation. Measurement results (in ml) of healthy and traumatized orbits were compared.

It is known that if the difference between volumes of injured and healthy orbits exceeds 2 ml, the globe can be displaced inferiorly by 1 mm, and therefore the risk of posttraumatic enophthalmos increases.

The difference between the volumes of injured and healthy orbits in the Patient N. was 0,4 ml, which is less than the critical point and suggested minimal risk of developing posttraumatic enophthalmos (Fig. 3).

Considering clinical presentation, absence of visual and functional impairment and results of CT including orbital volumes measurement, it was decided to treat patient symptomatically with follow-up.

As a part of a dynamic control CT of the midface was performed 2 years after the injury. The obtained images showed restoration of the right zygomatico-orbital complex with a small deformation of the inferior orbital wall (Fig. 4, 5).

Measurement of orbital volumes was performed as well in order to objectively estimate the changes. The difference between the affected and normal orbits in the late posttraumatic period was 0,67 ml which was still less than critical level (Fig. 6).

Considering the absence of any complaints within 2 years, satisfactory clinical condition, restoration of midface bone structures and absence of changes in orbital volumes, the choice of treatment tactic was acknowledge as successful.

**Discussion.**

Within the constant technical development, today we emphases on CT images processing in order to obtain objective diagnostic information. The use of these techniques allows doctors to choose the tactics of patient management, to plan the surgery, which will improve the efficiency and quality of treatment and rehabilitation of patients with orbital trauma [4-6, 8-10].

Orbital volume measurements are highly heterogeneous [6, 10]. The data obtained in recent studies are more reliable due to more accurate measurement and imaging techniques than in previous decades. Attempts to accurately measure the volumes of orbits have been made for a long time, but the research results still have not yet found wide application in clinical practice.

Among the wide range of orbital injury complications, two typical significant sequelae are enophthalmos and hypoglobus, based on posttraumatic orbital volume expansion [2, 4, 7, 9-11]. Critical values for surgical reconstruction of the orbit are considered to be the difference in position between the two eyeballs equal to 2 mm or more as measured in the anteroposterior plane by Hertel exophthalmometry [6-9].

Many studies show that the most reliable results of orbital volume measurements are obtained using CT [5-9]. However, despite the technological progress, it is still difficult to identify patients at risk of developing enophthalmos with orbital trauma, since edema and hematoma of the orbital soft tissues can hide enophthalmos up to 3 mm [10-13].

Many published studies in recent years have

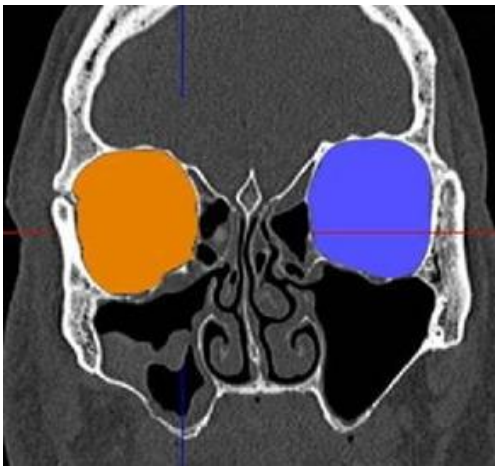

Fig. 3 a (Рис. 3 а)

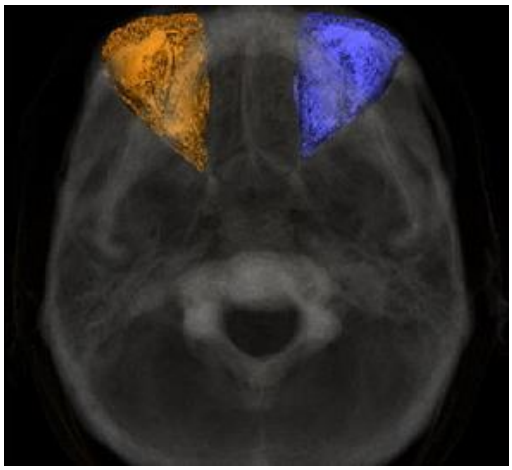

Fig. 3 b (Рис. 3 б)

**Fig. 3. MSCT, orbital volumes calculations.**

Coronal computed tomography image (a) and 3D model (b) in early posttraumatic period after calculating and highlighting the orbital volumes.

**Рис. 3. МСКТ, расчет объёмов орбит.**

Изображения в корональной плоскости (а) и 3D-модель (б) в раннем посттравматическом периоде после расчета и выделения объемов орбит.

Fig. 4 (Рис. 4)

**Fig. 4. Photo.**

View of the patient N. two years after the trauma (the agreement of the patient and the ethics committee for the photo was obtained).

**Рис. 4. Фото.**

Внешний вид пациента Н. через два года после травмы (согласие пациента и этического комитета на фотографию получены).

shown that an increase in orbital volume is directly correlated with the development and severity of enophthalmos [13, 14].

Large sample studies are needed to validate accurate mathematical measurements to prevent early enophthalmos greater than 2 mm, which requires surgical reconstruction of the orbital walls. To date and according to the results of published works, surgical reconstruction of the orbits should be indicated when the orbital wall defect is more than 2 cm2, and when the orbital volume increases by more than 1.62 cm3 or more than 10-15% [14, 16].

Many authors note that 3D assessment of the volume of the prolapsing component, in addition to 2D assessment of the orbital wall defect, may be necessary to determine the tactics of patient management and ensure an adequate surgical result [9-13, 15]. An analysis of the volume calculations showed that an increase in orbital volume of more than 5% can be considered sufficient for the appearance of clinically significant enophthalmos [10, 16].

Authors agree that the linear and volumetric characteristics of the bony orbit and its apex are useful in determining the tactics of patient management and assessing the volume of surgical intervention [14, 15]. This orbital volume measurement can be performed on every CT workstation with usual tools without any additional software indicating the reproducibility of the procedure.

Wagner M. et al in 2016 in their study showed that manual volume measurements as well as atlas-based and model-based methods can

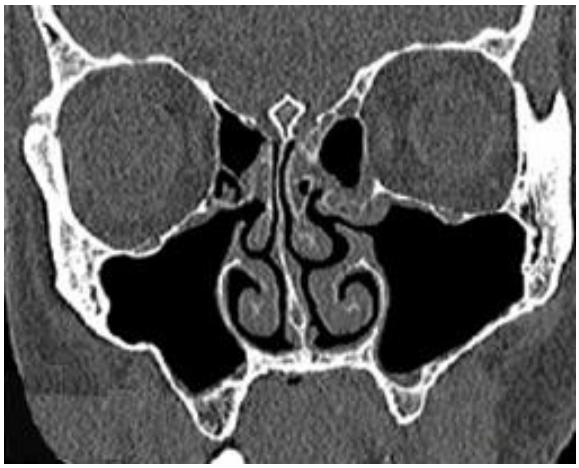

Fig. 5 a (Рис. 5 а)

Fig. 5 b (Рис. 5 б)

**Fig. 5. MSCT, bone window.**

a – coronal view, b – axial view. Coronal computed tomography image in late posttraumatic period, restoration of the left inferior and lateral orbital walls and maxillary sinus walls with slight deformations.

**Рис. 5. МСКТ, режим костной плотности.**

а – корональная проекция, б – аксиальная проекция. Отмечается восстановление левой нижней и боковой стенок правой орбиты с небольшой деформацией.

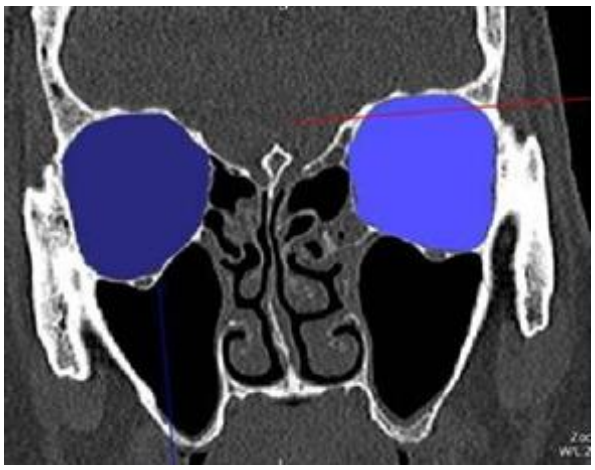

Fig. 6 a (Рис. 6 а)

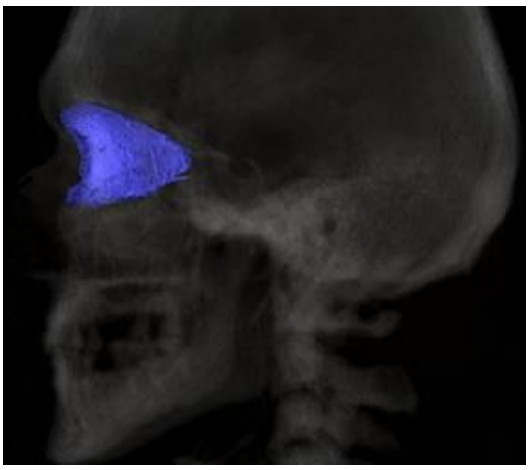

Fig. 6 b (Рис. 6 б)

**Fig. 6. MSCT, orbital volumes calculations.**

Coronal computed tomography image (a) and 3D model (b) in late posttraumatic period after calculating and highlighting the orbital volumes. .

**Рис. 6. МСКТ, расчет объёмов орбит.**

Изображения в корональной плоскости (а) и 3D-модель (б) в позднем посттравматическом периоде после расчета и выделения объемов орбит.

accurately measure orbital volume [16, 17]. Although automatic methods seem to be more userfriendly and less time-consuming, that manual volume measurements needed much less corrections and adjustments that is why it was used in our case.

In the presented clinical example we are showing the necessity of using CT data processing in challenging patients. This technique allows to get objective diagnostic information and to help the clinicians to choose the treatment tactics. Since the patients did not have any of screening criteria for detecting severe ocular injuries [17] and low risk of posttraumatic enophthalmos the surgery was not indicated which resulted in satisfactory outcome confirmed by follow-up CT.

Conclusion. This case highlights the advantage of using new techniques of CT data pro-

cessing in daily practice. As the result the additional diagnostic information about orbital volumes can be acquired in order to identify the risk of postoperative enophthalmos and allow clinicians to choose correct treatment tactics.

The authors do not have any proprietary interests in the materials described in the article. All coauthors have read, participated, and approved the final constructed manuscript. The photos of the patient were publishes with signed permission of the patient.

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