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Research Article

Where Should We Focus in Emergency Orbital Trauma?

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Abstract

Aim: To describe the most common findings in orbital trauma and to support radiologic decision making by comparing them in 7 pathology regions.

Material and Methods: A total of 190 patients (119 males and 71 females) participated in the study. Orbital injury pathologies were documented and compared in seven regions. The most typical results of orbital tomography were determined. Binominal regression analysis was also performed for each trauma region.

Results: 190 orbital CT scans showed 13.7% orbital bone fractures (n=26), 7.9% bulbus pathology (n=15), 2.6% vitreous pathology (n=5), 2.1% extraocular muscle pathology (n=4), and 6.3% (n=13) retrobulbar pathology. The most common globe pathologies were lens displacement and globe rupture. Retrobulbar fat plane changes (4.2% n=8) were the most common pathology in the region. Periorbital edema was the most common periorbital disease in 86.3% of cases (n=164). When evaluated using cross-tabulations between the seven pathologic regions, the relationship between bone pathology and retrobulbar area and between globe and vitreous was statistically significant ($p<0.05$). In binominal regression analyses, 5 trauma models were significant and showed more than 80 percent success in predicting trauma location ($p<0.05$).

Conclusion: Orbital fractures and pathologies of the retrobulbar space, globe and vitreous are interrelated. Radiologists should be familiar with orbital fracture patterns, potential soft tissue injuries and ocular anomalies and should be able to evaluate the relationship between pathologies.

Keywords: Orbital traumas, orbital tomography, computed tomography, prevalence

INTRODUCTION

Visual acuity and extraocular muscle motility are the two most crucial ophthalmologic functions to be assessed urgently in a patient with severe orbital damage (1). Due to the severity of the head injury, the degree of periorbital soft tissue edema, the inability of certain patients to cooperate, and the lower level of awareness in obtunded people, assessing these abilities can occasionally be challenging. As a result, computed tomography (CT) now plays a significant part in the orbital evaluation of patients with severe trauma (1, 2). Admissions to emergency rooms due to traumatic eye injuries are widespread everywhere. The diagnosis depends on the clinical examination, ocular sonography, and CT (3). Numerous ocular sequelae can result from blunt orbital damage. Ocular trauma more than doubles the risk of lens dislocation and retinal detachment after cataract surgery. The posterior lens can protrude into the vitreous far more frequently than the anterior lens can dislocate. Concomitant ocular injury, such as retinal tear or detachment, hyphema, or globe rupture, may occur in patients with lens displacement (4). A possible blinding complication of craniofacial trauma is retrobulbar bleeding, however prompt ocular examination might be challenging in some circumstances, and there are no established guidelines for canthotomy/cantholysis. Despite being a relatively uncommon sign on CT, tenting of the globe should alert the doctor to the need for action (5). Patients who sustain eyelid or orbital injuries may go to the emergency room or their primary care physician to have their injury assessed. These patients frequently have discomfort and bleeding around their eyes, which may

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make it challenging to assess them. Eyelid tears, orbital hemorrhages, intraorbital foreign objects, and orbital fractures are the most frequent injuries. Many acute eye injuries need quick medical treatment (6).

In this study, we set out to ascertain the frequency of radiological findings in emergency room patients who had orbital damage and had undergone orbital tomography.

MATERIAL AND METHOD

This study was approved by Kafkas University the Clinical Research and Ethics Committee. Due to the retrospective nature of the study, the requirement for written informed consent was waived.

Patients Selection

Orbital CT examinations requested from the emergency department between 01.01.2019 and 01.05.2022 were retrospectively scanned. 210 patients were included in the study. 4 patients were excluded from the study because of diffuse artifact in the images, and 9 patients due to the absence of orbital trauma etiology. Orbital CT reports of all patients were reviewed. Orbital CT reports were divided into 7 groups according to their pathology as Bone, Globe, vitreous, extraocular muscles, retrobulbar area, optic nerve and periorbital area. Orbital pathologies were recorded binomially in 7 regions where they were found. In 7 patients, it was excluded because there was not enough data in all fields in the reports.

Evaluation of CT Images

CT scans were done with Toshiba Alexion 32 Multi-Slice, Canon Medical Systems Corporation (Tochigi, Japan). In our radiology clinic, the orbital CT protocol consisted of 1mm coronal, axial and sagittal sections. Patients' age, gender, the patients' age, gender, orbital pathology in which area, characteristics of orbital pathologies were recorded and compared.

Statistical Analysis

The Statistical Packages for Social Sciences (SPSS Chicago, IL, USA) version 25 was used for data analysis. All variables except age are in categorical variables. Categorical variables were evaluated with cross tables among themselves. There were no outliers or multicollinearity in the data set. To determine the most important categorical variable for each location, a binominal regression model was applied independently to each region. The most significant pathologic location, model success, the amount of variation explained (R2), and the significance of the regression models were all examined. P value <0.05 was considered statistically significant.

RESULTS

In the study, 190 patients, 71 females and 119 males, were evaluated. The mean age of the patients was 35.34±23.24 years. 13.7% (n=26) orbital bone fracture, 7.9% (n=15) bulbus pathology, 2.6% (n=5) vitreous pathology, 2.1% (n=4) extraocular muscle pathology, 1% (n=2) optic nerve pathology, 6.3% (n=12) retrobulbar pathology, were all detected in 190 orbital CT scans (Table 1). In all patients 5.2% (n=10) orbital floor fracture, 3.1% (n=6) medial wall fracture, 2.6% (n=5) orbital roof fracture, 1.6% (n=3) mixed fracture and 1% (n=2) lateral wall fracture was detected. The most frequent globe pathologies were lens displacement and globe rupture. 2.6% (n=5) of the patients had vitreous hemorrhage found. Figure 1-4 presents glob perforation cases, lens dislocation cases and fracture cases. Four individuals (2.1%) had medial rectus muscle thickening. In 2 individuals, the optic nerve had thickened. Retrobulbar fat planes changes (4.2% n=8) were the most prevalent pathology in the region. In 86.3% (n=164) of cases, periorbital edema was the most prevalent periorbital disease. Other results included hemorrhage in the maxillary sinus 5.3% (n=10), foreign body 3.2% (n=6), subcutaneous emphysema 2.6% (n=5), and hematoma 2.6% (n=5).

Table 1. Descriptive findings of 190 patients

		N:	%	N:190
Gender	Female	71	62.6	62.6%
	Male	119	37.4	37.4%
Age	35.34±23.24			
Orbital fracture	Floor	10	38.5	5.2%
	Medial wall	6	23.1	3.1%
	Roof	5	19.2	2.6%
	Mix	3	11.5	1.6%
	Lateral wall	2	7.7	1.0%
Globe	Lens dislocation	6	40.0	3.1%
	Globe rupture	4	26.7	2.1%
	Foreign body	2	13.3	1.0%
	Exophthalmos	2	13.3	1.0%
	Scleral plaques	1	6.7	0.5%
Vitreous	Vitreous hemorrhage	5	100	2.6%
EOM	Thickening of the medial rectus	4	100	2.1%
Optic nerve	Thickening of the optic nerve	2	100	1.0%
Retrobulbar	Heterogeneous retrobulbar fat	8	61.5	4.2%
	Retrobulbar air	3	23.1	1.6%
	Retrobulbar foreign body	2	15.4	1.0%
Periorbital	Edema	164	86.3	86.3%
	Hemorrhage in the maxillary sinus	10	5.3	5.3%
	Foreign body	6	3.2	3.2%
	Hematoma	5	2.6	2.6%
	Subcutaneous emphysema	5	2.6	2.6%

The association between bone pathology and the retrobulbar area, as well as the relationship between the globe and vitreous, were determined to be statistically significant when assessed using cross tables among the seven pathological regions (Table 2). It was shown that the retrobulbar area was impacted by bone fractures in the binominal regression analyses carried out for each location (Table 3). Globe pathologies and vitreous pathologies were significantly correlated. In the periorbital region paradigm, periorbital pathology was often present when the globe was afflicted. In the 5 stated models, more than 80% success was attained.

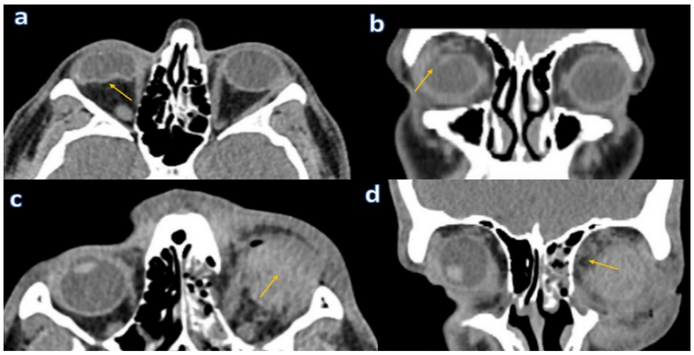

Figure 1. Cases of globe perforation: **1a.** 33 years old male patient with blunt trauma to the right eye showing irregularity in the posterior contour of the globe on axial CT image (arrow) **1b.** Coronal CT image shows a globe posterotemporal defect consistent with perforation (arrow) **1c.** Axial CT image of a 15-year-old male patient portrays increased vitreous density consistent with hemorrhage after trauma (arrow) **1d.** Coronal CT image of the same patient shows an intra-glob air focus (arrow) and contamination of the fat planes

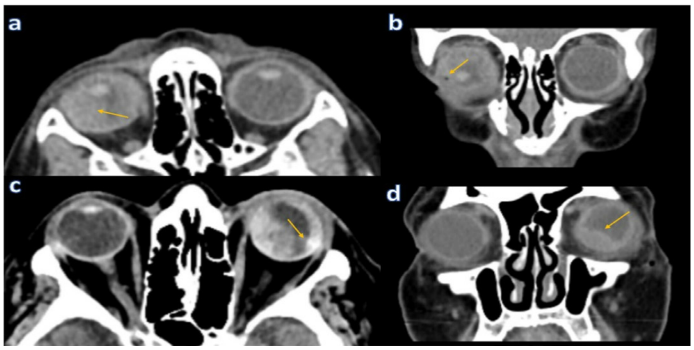

Figure 2. Lens dislocation and vitreous hemorrhage **2a.** A 33-year-old female patient is admitted to the emergency room because of glass in her eye. Axial CT image reveals diffuse vitreous hemorrhage (arrow) **2b.** Coronal CT image demonstrates millimetric air density in the globe consistent with perforation (arrow) **2c.** 69-year-old woman hit her left eye on a nightstand after a fall. The crystalline lens is dislocated posterolaterally in the left eye (arrow) **2d.** Coronal CT image of the same patient presents leveling hemorrhage in the vitreous (arrow)

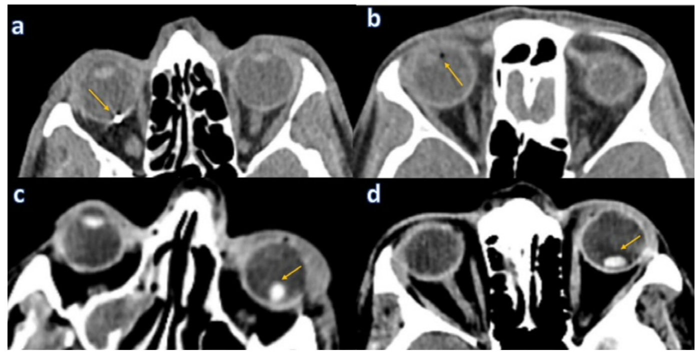

Figure 3. Foreign body, glob air focus and lens dislocation **3a.** 53 years old male patient with foreign body density inside the eye (arrow) **3b.** A 24-year-old woman presented with an intra-globe air focus on an axial CT image with a focus in the eye. Ophthalmologist detected corneal incision and iris problapse. The air finding is consistent with perforation (arrow) **3c.** A 31-year-old male patient is admitted to the emergency room due to battery. Axial orbital CT image reveals a dislocation of the lens of the left eye (arrow) **3d.** A 46-year-old woman has a dislocation of the left eye lens after an object from the kitchen cupboard fell into her eye (arrow)

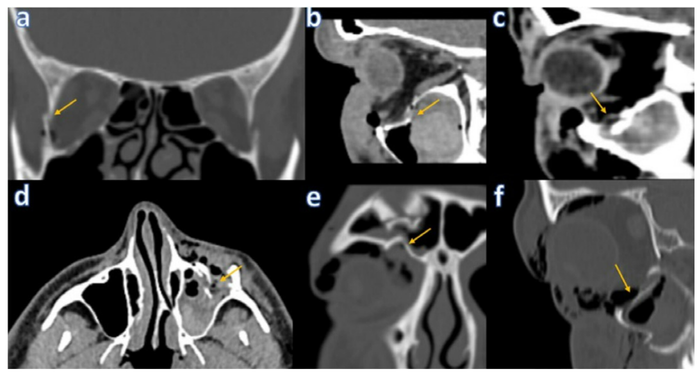

Figure 4. Fracture cases **4a.** Coronal CT image presents a fracture in the orbital lateral wall **4b-f.** Sagittal orbital CT image shows displaced fracture of the orbital inferior wall and air densities **4c-d.** 34 years old male bear attack with diffuse displaced fractures to the inferior wall of the orbit, air images and hemosinus **4e.** Coronal CT image visualized a displaced fracture in the upper wall of the orbit

Table 2. Crosstab of the distribution of orbital pathologies (P values)

	Bone	Glob	Vitreous	EOM	Optic N	Ret	Periorbital
Bone	X	0.967	0.367	0.421	0.571	0.004*	0.046*
Glob	0.967	X	0.000*	0.554	0.026*	0.023*	0.000*
Vitreous	0.367	0.000*	X	0.740	0.815	0.556	0.707
EOM	0.421	0.554	0.740	X	0.835	0.121	0.411
Optic Nerve	0.571	0.026*	0.815	0.835	X	0.004*	0.265
Retrobulbar	0.004*	0.023*	0.556	0.121	0.004*	X	0.016*
Periorbital	0.046*	0.000*	0.707	0.411	0.265	0.016*	X

Table 3: Model successes and most significant variables according to Binomial Regression Analysis

	Model	R^2	Success (%)	Variable	Sig	Exp(B)	%95 CI
Bone	0.025	14%	86.3	Retrobulbar	0.006	7.815	1.819-33.570
Glob	0.000	31%	92.1	Vitreous	0.001	34.661	4.318-278.256
Vitreous	0.039	31%	97.4	Glob	0.001	46.037	5.040-420.508
EOM	0.390	17%	-	-	-	-	-
Retrobulbar	0.000	35%	95.3	Bone	0.005	8.060	1.869-34.755
Periorbital	0.001	20%	85.8	Glob	0.000	10.159	2.786-37.039

DISCUSSION

There was no discernible connection between ocular damage and an orbital wall fracture. Alarm symptoms for more serious visual injuries such retinal tears, detachments, open globe injuries, and extraocular muscle entrapment are all valid reasons to seek emergency ophthalmology care. The majority of orbital fractures do not normally require surgical treatment, pose little harm to eyesight (7). Blowing-in fractures seldom result in globular indentation. In cases of high-velocity trauma to the superolateral orbit accompanied by hypoglobus, motility restriction, and indentation of the globe on dilated examination, clinicians should be wary. Good visual, functional, and aesthetic results can be achieved with early identification and surgical excision of the compressive orbital bone fragments in a multidisciplinary manner (8). Fractures of the medial and orbital walls are frequent midface injuries. Due to the complicated architecture of the related bone and soft tissues, orbital fractures have a unique mechanism of trauma. When treating patients who appear with orbital damage, anatomical knowledge is crucial (9). The purpose of therapy is to reestablish physiologic and aesthetic function. The issue with orbital burst fractures is that they can cause an increase in orbital volume, which can lead to enophthalmos and hypoglobus. Bone fragments may also enter the orbital tissue and inferior rectus muscle, causing diplopia, gaze restriction, and tension. Finally, retinal edema, hyphema, and severe vision loss might result from orbital damage. While some instances can be treated conservatively, others could necessitate surgical intervention (10). In research examining the prevalence of ocular damage related to maxillofacial trauma from 2015 to 2020, a retrospective evaluation of 1677 patients with midface fractures at a Level I trauma center was performed. The most common cause of trauma was being beaten (63.8%). There was a statistically significant correlation between the mechanism of damage and ocular injury. Ocular damage was seen in 44.3% of assault patients and 78.6% of patients with gunshot wounds. 36% of patients experienced minor eye damage, while 10.5% experienced significant ocular injury. In 46.1% of cases, isolated orbital floor fractures were found. All patients with midface fractures should have ophthalmologic exams to help with clinical decision-making and stop further intraoperative eye injury (11). Following an orbital fracture, ocular pathology (OP) can range greatly in complexity and severity. When there has been orbital damage, there are either asymmetrical or symmetrical patterns of extraocular motility (OME) restrictions. 278 orbitals with wall fractures were retrospectively investigated as part of a study to see whether there is any correlation between higher OP after instances of orbital fractures based on the pattern of OME defects. OME restriction was observed to be significantly correlated with greater occlusal pathology following orbital damage. Ocular pathology was more prevalent in instances with symmetrical and asymmetrical OME limitations than in those without them, with odds ratios of 7.9 (95% CI: 2.3-27.2) and 5.22 (95% CI: 1.9-13) times greater respectively. A common finding in cases of orbital fracture is ocular pathology. Although doctors may expect ocular pathology in circumstances of any limitation of OME, symmetrical limitations of OME may increase the likelihood of intraocular damage (12). Radiology focuses on a study examining the clinical manifestation of entrapment and entrapment in the extraocular muscles. 2.8% of patients experienced clinical entrapment, whereas 67% described feeling "stuck" or "trapped." OME herniation was associated with increased risk for entrapment, diplopia, and irregular OME motility, but it also had a 7.9% positive predictive value for clinical entrapment. The independent positive predictive values for fat herniation and OME contour irregularity were 4.2% and 4.8%, respectively. Despite the fact that individuals with OME herniation appear to have a greater chance of being entrapped, this imaging result does not indicate clinical entrapment. The likelihood of entrapment was not increased by fat herniation or abnormal OME contours, and neither were they predictive. Only further CT should be used to support the primary physical examination-based diagnosis of orbital entrapment. Inadvertent inter-site transfers, sub-specialist consultations, and emergency surgical treatments may be carried out as a result of the notion that radiographic data imply orbital crises (13). An intense level one trauma center's treatment of orbital bone fractures was examined for injury patterns and cause. The group identified to be most impacted was between the ages of 20 and 29 (36%). Interpersonal violence was the most frequent cause (55%) followed by falls (20%) and road accidents (12%). The orbital floor was the location of solitary orbital bone fracture most frequently (40%). According to reports, the zygoma is the structure next to the orbit that is most frequently affected by impure orbital fractures (19%) (14). The most frequent cause was blunt injury in research looking at the frequency of major minor ocular damage or orbital fracture. Subconjunctival hemorrhage was the most typical injury (53.5%). Particularly in cases with severe damage coupled with globe rupture, the posterior segment findings of globe rupture (2.9%) and vision-threatening posterior segment symptoms such retinal tear and choroidal rupture (1.3%) were recorded as just one retinal detachment (0.2%) (15). Scleral irregularity was the most frequent CT finding in open globe damage, followed by crystalline lens displacement (54%) and vitreous hemorrhage (51%). The axial, coronal, and combined CT plans had sensitivity values of 74%, 65%, and 79%, respectively. Regardless of the kind and location of the globe damage, there was no significant difference noted between axial and coronal CT scans in the detection of open globe injuries. The sensitivity of identifying open globe injury of the coronal plane is much lower than axial and combined readings for posterior injuries and acute trauma, and the axial CT reading may be as good as a multiplanar reading for open globe injury detection. CT cannot detect open globe injuries with adequate accuracy in the absence of clinical and surgical signs (16). In our study, we showed the most common findings in orbital traumas and which areas may be related to each other. Primary and secondary lesions may be overlooked in radiology examination. Following clues sometimes helps to find the primary lesion to catch secondary signs. Secondary findings such as intraocular fat herniation, OME trap, bone fragments are important. Improve your understanding of the extraocular muscles' connection to the fracture margins by using the coronal reconstruction.

The radiologist should focus on the orbit apex in patients who report of a sudden post-traumatic reduction in visual acuity to rule out fractures. The purpose of a CT scan in a hyphema case is to evaluate the posterior chamber and determine whether any related injuries are present (17). Look for the presence of foreign bodies and related orbital injuries when the vitreal hemorrhage is evident. The lens's look following cataract surgery should be known to the radiologist. Some ocular abnormalities, such as coloboma and staphyloma, might resemble an open globe damage. Radiologists need to be wary of wooden foreign bodies since they might seem like air and be hypoattenuating and linear (18).

Study Limitations

Our study is a single-center retrospective study. Emergency orbital traumas were evaluated in the secondary care center.

CONCLUSION

Various fracture patterns may develop from orbital trauma. The gold standard for assessing ocular trauma damage and choosing the most effective treatment option is CT. For a quick and precise diagnosis, it's crucial to be aware of the most prevalent pathologies and the related areas. The radiologist must comprehend and be conversant with fracture patterns, potential soft tissue injuries, and anomalies in the eye and globe in order to establish the proper course of therapy.

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Conflict of Interest: *The authors have no conflicts of interest to declare.*

Ethical approval: *This study was approved by the Kafkas University Clinical Research and Ethics Committee on May 26, 2021 (decision number 06-20).*

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