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# Determining the Sensitivity in the Diagnosis of Preoperative Orbital Computed Tomography in Patients With Open Globe Injury and Evaluating the Affecting Factors

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## ABSTRACT

**Purpose:** Open globe injuries are diagnosed by ophthalmological examination. The purpose of this study is to determine the sensitivity in the diagnosis of preoperative orbital computed tomography (CT) in our patients with open globe injury and to evaluate the affecting factors.

**Materials and Methods:** The data of patients who underwent open globe injury repair between September 2014 and February 2021 in the Akdeniz University Hospital Ophthalmology Clinic were retrospectively analyzed. Demographic data of 290 patients' were recorded. Patients suffer from corneal, scleral and corneoscleral injury; classified as pediatric and adult age groups. The presence of open globe injury, foreign body (FB) and orbital fracture in the preoperative orbital CT report were recorded.

**Results:** Sixty (20.7%) women and 230 (79.3%) men were included in the study. Of the patients, 58 (20%) were pediatric and 232 (80%) were adults. There were corneal, 76 (26.2%) scleral, and 59 (20.3%) corneoscleral injuries in 155 (53.4%) patients. In the preoperative orbital CT report, it was stated that 163 (56.2%) patients had open globe injuries. We did not observe any statistical difference between the diagnostic efficiency of orbital CT in pediatric and adult groups ( $p=0.636$ ). When we evaluate according to the location of wound; scleral and corneoscleral injuries were compared with corneal injuries, we found that orbital CT was more effective in diagnosing ( $p<0.001$ ). Similarly, as the length of wound increased, the diagnostic efficiency of orbital CT increased ( $p<0.001$ ).

**Conclusion:** In this study, we found the sensitivity of orbital CT in diagnosing open globe injury as 56.2%. Diagnostic efficiency increases in the presence of scleral and corneoscleral injuries and a full-thickness incision greater than 4 mm. We found that age, gender, and presence of orbital fracture had no effect on the sensitivity of orbital CT in diagnosing open globe injury. It should be kept in mind that nearly half of the patients may miss the diagnosis by orbital CT.

**Keywords:** Open globe injury, Orbital CT, Trauma

## Açık Glob Yaralanmalarında Orbital Bilgisayarlı Tomografinin Tanı Koymadaki Duyarlılığı ve Buna Etki Eden Faktörlerin Değerlendirilmesi

### ÖZET

**Amaç:** Açık glob yaralanmalarının tanısı oftalmolojik muayene ile konulmaktadır. Bu çalışmanın amacı açık glob yaralanması olan hastalarımızda acil şartlarda istediğimiz preoperatif orbital bilgisayarlı tomografinin (BT) tanı koymadaki duyarlılığının saptanması ve buna etki eden faktörlerin değerlendirilmesidir.

**Gereç ve Yöntem:** Akdeniz Üniversitesi Hastanesi Göz Hastalıkları kliniğinde Eylül 2014 - Şubat 2021 tarihleri arasında açık glob yaralanması onarımı yapılmış hastaların verileri retrospektif olarak incelendi. Verilerine ulaşılabilen 290 hastanın demografik verileri kaydedildi. Hastalar korneal, skleral ve korneaskleral yaralanma; pediatrik ve erişkin yaş gurubu olarak sınıflandı. Preoperatif orbital BT raporundaki açık glob yaralanması, YC ve orbital fraktür varlığı kaydedildi.

**Bulgular:** Çalışmaya 60 (%20,7) kadın, 230 (%79,3) erkek dahil edildi. Hastaların 58 (%20) pediatrik, 232'si (%80) erişkindi. 155 (%53,4) hastada korneal, 76 (%26,2) skleral ve 59 (%20,3) korneaskleral yaralanmaydı. Preoperatif çekilen orbital BT raporunda 163 (%56,2) hastada açık glob yaralanması olduğu belirtilmişti. Pediatrik ve erişkin gruplarda orbital BT tanı koyma etkinliği arasında herhangi bir istatistiksel fark izlemedik ( $p=0,636$ ). Kesi yerine göre değerlendirdiğimiz zaman; skleral ve korneaskleral yaralanmalar korneal yaralanmalar ile karşılaştırıldığında orbital BT'nin tanı koyma etkinliğinin daha fazla olduğunu gördük ( $p<0.001$ ). Benzer şekilde kesi uzunluğu artınca orbital BT'nin tanı koyma etkinliği arttı ( $p<0.001$ ).

**Sonuç:** Bu çalışmamızda orbital BT'nin açık glob yaralanma tanısı koymadaki duyarlılığını %56,2 olarak bulduk. Skleral, korneaskleral yaralanmalar ve 8 mm üzerinde tam kat kesi varlığında tanı koyma etkinliği artmaktadır. Yaş, cinsiyet ve orbital fraktür varlığı orbital BT'nin açık glob yaralanması tanısını koymadaki duyarlılığına bir etkisinin olmadığını gördük. Hastaların yarısına yakınında tanıyı atlayabileceği akıld tutulmalıdır.

**Anahtar kelimeler:** Açık glob yaralanması, Orbital BT, Travma

**O**pen globe injuries are important causes of morbidity and monocular blindness (1,2). All full-thickness globe injuries are called open globe injuries (3,4). Clinical signs and symptoms include decreased visual acuity, hyphema, decreased anterior chamber depth, pupillary irregularity, hypotonia and prolapse of intraocular tissues. However, most cases of severe ocular trauma are both a diagnostic and treatment challenge to the ophthalmologist and emergency physicians (5,6). Findings such as eyelid edema and subconjunctival hemorrhage make ophthalmological examination and diagnosis difficult. In such cases, radiological imaging methods are used to support the diagnosis. Ultrasonography is contraindicated in cases that open globe injury is suspected (7). Magnetic resonance (MR) shows orbital soft tissues in detail, but is not used in trauma patients due to the risk of metallic intraocular foreign bodies (7).

Orbital computed tomography (CT) is the first-choice imaging modality to obtain information about the severity and extent of trauma in ocular trauma patients (8). It is particularly helpful in imaging orbital bone structures and fractures. In open globe injuries, it has been reported that the diagnostic sensitivity is between 56-75%, although it varies depending on the radiologist (8-10). Change in globe contour, decrease in globe volume, scleral irregularity, presence of air or foreign body in the globe are CT findings in open globe injury. The role of orbital CT in demonstrating orbital bone structures and foreign body presence in trauma patients is certain. In this study, we aimed to evaluate the sensitivity of orbital CT in diagnosis of open globe injury and the factors affecting sensitivity (10,11).

## MATERIALS AND METHODS

In our study, the data of 290 patients who underwent primary repair due to open globe injury in Akdeniz University Hospital Ophthalmology department between September 2014 and February 2021 were evaluated retrospectively. Our study which was conducted in accordance with the principles of the Declaration of Helsinki was approved by local ethics committee of Akdeniz University Faculty of Medicine (KAEK:639 / 15.09.2021).

Demographic characteristics of the patients, localization and size of wound were recorded. The preoperative orbital CT report was obtained from hospital records. Increase or decrease in anterior chamber depth, scleral contour irregularity, absence of scleral wall integrity, decrease in globe volume, and presence of air or foreign body in the

globe were passed for open globe injury. In addition, the presence of intraorbital foreign body and orbital fracture were also recorded. Depending on the location of the wound, the patients are classified by corneal, corneoscleral and scleral. According to age group, patients are classified by pediatric and adult. Patients who underwent open globe injury repair in our clinic and whose preoperative orbital CT data were accessed were included in the study. Patients whose primary repair was performed in an external center and data could not be accessed were excluded from the study.

## Statistical Analysis

Statistical analyses were performed using IBM SPSS 23.0 for Windows (IBM Corp, Armonk, NY, USA). Kolmogorov-Smirnov test was used for normality distribution. Continuous variables were given as mean  $\pm$  standard deviation, and categorical variables were given as frequency (percentage). Comparisons between groups were made using the independent simple t-test on independent samples. Comparisons of categorical variables were evaluated with chi-square ( $\chi^2$ ) analysis. ROC analysis was used and cut-off values are calculated with area under the ROC curve (AUC). P value less than 0.05 was considered statistically significant.

## RESULTS

290 eyes of 290 patients were included in the study. The demographic characteristics of the patients are summarized in Table 1. In gender distribution, open globe injuries were statistically higher in males ( $p < 0.001$ ). The mean age was  $35.76 \pm 19.81$  years; was  $41.2 \pm 9.1$  in the adult group and  $13.9 \pm 4.2$  in the pediatric group. We found that open globe injuries were more common in the adult age group compared to the pediatric age group ( $p < 0.001$ ). In addition, we found that open globe injuries were more common in males in both pediatric and adult age groups ( $p < 0.05$ ).

In the preoperative orbital CT reports, 163 (56.2%) patients had open globe injuries; it was also stated that 61 (21%) patients had foreign bodies and 10 (3.4%) patients had orbital fractures.

When we evaluate according to the wound site; we found that the diagnostic efficiency of orbital CT was higher in scleral and corneoscleral injuries compared to corneal injuries ( $p < 0.001$ ). Similarly, there was a positive correlation between the wound length and the diagnostic efficiency of orbital CT ( $p < 0.001$ ). Especially, we used ROC analysis

and performed that orbital CT diagnoses open globe injury with a higher rate in wounds larger than 4 mm, while the success of diagnosis decreases in wounds of 4 mm and smaller (AUC = 0.885,  $p < 0.001$ ).

58 patients were in pediatric group and 232 patients were in the adult group that we repaired as open globe injuries. We found orbital CT sensitivity 53.5% in the pediatric group and 56.7% in the adult group. In terms of gender distribution, the sensitivity of orbital CT was 51.7% in women and 57.4% in men. Sensitivity of orbital CT was 52.8% in the group with orbital fracture and 53.7% in the group without fracture. We found that age, gender, and presence of orbital fracture had no effect on the sensitivity of orbital CT in diagnosing open globe injury ( $p = 0.636$ ,  $p = 0.426$ ,  $p = 0.707$ , respectively).

Table 1. Demographic characteristics of patients		
Gender (n (%))	Male	230 (79.3%)
	Female	60 (20.7%)
Age (n (%))	Adult	232 (80%)
	Pediatric	58 (20%)
Age (mean, years)		35.76 ± 19.81
Length of the wound (mm)		6.11 ± 3.79
Location of the wound (n (%))	Corneal	155 (53.4%)
	Corneoscleral	76 (26.2%)
	Scleral	59 (20.3%)

## DISCUSSION

Birmingham Eye Trauma Terminology defines full-thickness eye injuries as open globe injuries (2). Open globe injuries are an important public health problem resulting in vision loss in both developed and developing countries. The diagnosis of open globe injury is made by the presence of a full-thickness globe tissue injury. Depending on the type and severity of the trauma, it may become very difficult to diagnose, especially in blunt traumas. Radiological imaging methods are used to support the diagnosis.

Orbital CT is preferred as the first choice imaging method in trauma patients in emergency conditions. Orbital CT provides information about globe integrity, presence of foreign body and orbital bone structures. Orbital CT is not valuable as clinical examination when anterior segment

details are clear. However, increase or decrease in anterior chamber depth, scleral contour irregularity, absence of scleral wall integrity, decrease in globe volume and presence of air or foreign body in the globe in orbital CT are the findings suggesting open globe injury (8,12-14).

In this study, we found the sensitivity of orbital CT in diagnosing open globe injury as 56.2%. This rate has been reported to be between 56-75% in previous studies (8-10). In open globe injuries that are not clinically obvious, the rate falls to the range of 56-68% (8). Although the rate in our study is relatively low, we see that it is similar to previous studies. In our study, orbital CT reports were analyzed retrospectively and these reports consist of reports that are rapidly evaluated in emergency conditions. It has been suggested in the literature that this rate difference may be due to the experience of the interpreting radiologist (10,15,16).

When we consider age distributions, we did not see any statistical difference in the diagnostic efficiency of orbital CT between the pediatric group and the adult group. The globe is smaller in the pediatric age group. We concluded that this size difference does not increase the risk of missing the diagnosis with imaging methods. Likewise, gender and the presence of orbital fracture did not make a significant difference in the diagnostic efficiency of orbital CT.

When we evaluated according to the wound sites, we saw that the diagnostic efficiency of orbital tomography was lower in corneal injuries. There is a change in anterior chamber depth in corneal wounds generally. In emergency conditions, anterior chamber depth is evaluated cursory in orbital CT reports. Therefore, the diagnosis of isolated corneal open globe injuries may be missed. Joseph et al. reported that the rate of change in anterior chamber depth on orbital CT in open globe injuries was 48-86% (15). Therefore, inconspicuous changes in anterior chamber depth can be missed in the orbital CT report evaluated in emergency conditions.

When we consider the length of the wound site, we observed that the diagnostic efficiency of orbital CT increased especially in cases with a diameter of 4 mm and above. As the wound length increases, the effect of the globe increases; therefore, the visibility of existing findings in orbital CT also increases.

The limitation of the study is retrospective design and relatively small number of patients included. Data included in the study were selected to test the sensitivity of imaging-based diagnosis. There are many studies in the literature evaluating the sensitivity of orbital CT in open globe injuries; however, we did not find a study examining the factors affecting sensitivity. We suggest that this study is important because it has look from a different perspective about the subject.

In conclusion, open globe injuries are an ophthalmologic emergency diagnosed by clinical examination. Orbital CT is the first-choice imaging method that can be performed in trauma patients in emergency conditions. The sensitivity of orbital CT in diagnosing open globe injury is similar in pediatric and adult age groups. Similarly, gender and the presence of orbital fracture do not affect sensitivity. Diagnostic efficiency increases in the presence of scleral and corneoscleral injuries and a full-thickness wound greater than 4 mm. Although orbital CT is not the first choice in diagnosing open globe injury, it is important in terms of supporting the diagnosis and detecting foreign body and orbital fracture. It should also be kept in mind that orbital CT may miss the diagnosis in nearly half of open globe injuries.

## DECLARATIONS

### Funding

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### Conflict of Interest

The authors declare that they have no conflict of interest.

### Ethical Approval

This study was approved by the Ethics Committee of the Akdeniz University Faculty of Medicine (KAEK:639 / 15.09.2021). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

### Availability of Data and Material

All data and material are available on request from the authors. The data that support the findings of this study are available from the corresponding author, [A.Ç.Y.], upon reasonable request.

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