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ETIOLOGICAL FINDINGS AND VISUAL OUTCOMES OF OCULAR INJURIES IN PEDIATRIC PATIENTS

PEDİATRİK HASTALARDA OKÜLER TRAVMALARIN ETİYOLOJİK ÖZELLİKLERİ VE GÖRSEL SONUÇLARI

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Abstract

Objective: To investigate the demographic characteristics and prognostic factors of 60 pediatric patients who applied to our emergency clinic due to open globe injury (OGI) and were treated and followed up.
Methods: The medical records of 69 patients aged 16 years and younger, who were operated for OGI between 2010-2021 and followed up for at least one year, were retrospectively reviewed. The patients' demographic data, the type, cause and mechanism of injury, wound location and accompanying examination findings at the time of admission, time of admission to the hospital, first and last visual acuities (VA), additional surgeries were collected from the records.
Results: The mean age was 11±5 years old. 17.4% were girls and 82.6% were boys. The most common shape of OGI was corneal incision, the most common etiological cause was sharp and penetrating objects (65.1%). Only zone 1 was affected in 87% of the cases, zone 2 in 40.6%, and zone 3 in 13%. Relative afferent pupil defect (RAPD) was present in 37.7% of the cases. Rupture was 5.8%, retinal detachment 8.7%, endophthalmitis 2.9%, perforating injury 4.3%. While VA cannot be evaluated in 7% of the cases at the time of admission, it is 0.1 or less in 60%, 0.1-0.6% in 25.7%. 4.3% had a VA better than 0.6. In the sixth month of follow-up, VA could not be evaluated in 2.9% of the cases, while VA was 0.1 or less in 11.4%, 0.1-0.6 in 25.7%, and better than 0.6 in 60%. Ocular trauma score (OTS) was 74±16 and pediatric ocular trauma score (POTS) was 64±19. OTS was moderately correlated with baseline VA (r=0.687, p<0.001) and moderately correlated with follow-up VA (r=0.611, p<0.001). Correlation values of pediatric ocular trauma score were lower (r=0.574, p<0.001) with baseline VA.
Conclusion: Even though RAPD cannot be evaluated, OTS is a reliable tool to predict visual prognosis in pediatric OGI.

Keywords: *Ocular trauma, blindness, eye injury, penetrating eye injury, childhood eye injury.*

Öz

Amaç: Açık glob yaralanması (AGY) nedeni ile acil kliniğimize başvuran, tedavi ve takibi yapılan 60 pediatrik olgunun demografik özelliklerini ve prognozu etkileyen faktörleri araştırmak.
Yöntem: Kliniğimizde 2010-2021 yılları arasında AGY nedeni ile ameliyat edilip, en az bir yıl takip yapılmış olan 16 yaş ve altı 69 olgunun dosya kayıtları retrospektif olarak incelendi. Kayıtlardan AGY'nin tipi, oluş nedeni, eşlik eden muayene bulguları, hastaneye başvuru zamanı ile ilk ve son görme keskinlikleri (GK), ek cerrahileri kaydedildi.
Bulgular: Olguların ortalama yaşı 11±5 yıl idi. %17,4'si kız %82,6'sı erkek idi. AGY'nin şekli en sık korneal kesi, en sık etiyolojik nedeni kesici ve delici aletler (%65,1) oluşturmakta idi. Olguların %87 sinde sadece bölge 1, %40,6 sında bölge 2, %13 ünde bölge 3 etkilenmişti. Olguların %37,7 sinde relatif afferent pupil defekti (RAPD) vardı. %5,8'i rüptür, %8,7'si retina dekolmanı, %2,9'u endoftalmi, %4,3'ü perforan yaralanma idi. Olguların başvuru anında %7'sinde GK değerlendirilemezken, %60'ında 0.1 ve daha altında, %25,7'sinde 0.1-0,6. %4,3'ünde ise 0.6'dan daha iyi GK'ya sahipti. Olguların takiplerinde 6. ayda ise %2,9' unda GK değerlendirilemezken (inop), %11,4' ünde 0.1 ve daha altında, %25,7'sinde 0.1-0.6 ve %60'ında ise 0.6'dan daha iyi GK'ya sahipti. Oküler travma skoru (OTS) 74±16, pediatrik oküler travma skoru (POTS) 64±19 idi. OTS başlangıçtaki GK ile orta derecede ilişkili (r=0,687, p<0,001), takipteki GK ile orta derecede ilişkili (r=0,611, p<0,001) idi. Pediatrik oküler travma skorunun korelasyon değerleri ise daha düşük bulundu (başlangıç GK ile r=0,574, p<0,001).
Sonuç: Pediatrik AGY'de görsel prognozu tahmin edebilmek için RAPD değerlendirilemediğinde bile OTS güvenilir bir araçtır.

Anahtar Kelimeler: *Oküler travma, körlük, göz yaralanması, penetran göz yaralanması, çocukluk çağı göz yaralanması.*

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Introduction

Childhood eye trauma is a preventable cause of non-congenital visual morbidity.[1-3] Considering the life expectancy in children, preventing a globe trauma and knowing the prognostic factors carry a vital risk. If the social aspect of the trauma is also included, there will be the possibility of being emotionally hurt for a lifetime when he/she goes through a difficult experience.[2,4-7]

Children's experience and competencies are different from adults. Children cannot imagine how much harm they would do to themselves and their environment.[8-9]

In addition, eye accidents occur more frequently because their motor skills are not fully developed. Therefore, it is important to prevent traumas that can potentially affect children's life and wellness and potentially affect their future.

The distribution of pediatric ocular traumas admitted to the emergency department ranges from self-limiting processes to vision or life-threatening conditions. Like any pediatric examination, the patient's age and underlying behavior can significantly assist with or hinder examination.[10-11] The nature of the trauma can vary from self-limiting processes to vision-threatening situations.

Visual acuity (VA) is a vital indicator of the severity of the trauma and it has been stated in previous studies that one of the most important factors determining the prognosis after eye trauma is the VA detected at the first examination, and therefore it should have the highest priority in the evaluation of the pediatric patient.

Ocular trauma scores (OTS) have been developed to predict outcomes and aid in triage of globe injury.[11-13] Significant weighting of initial VA may incorrectly bias the ocular trauma score in a pediatric population. Although this scoring system has been accepted in many studies, it can be difficult to evaluate two important criteria in OTS, namely VA and RAPD, especially in traumatized children. This scoring system reduced the emphasis on presenting VA as a prognostic factor and suggested pediatric ocular trauma score (POTS) as an alternative way to predict visual outcome in cases especially where initial VA could not be obtained.13

In this study, we aimed to investigate the demographic characteristics, prognosis and the factors affecting the prognosis of 69 pediatric cases who applied to our emergency clinic due to open eye injury.

Methods

The file records of 69 patients aged 16 years and younger, who were operated for OGI in our clinic between 2010 and 2021, were followed up regularly for at least one year, were reviewed retrospectively. Approval of the local ethics committee of our hospital was obtained for the study (KÜ GOKAEK-2022/02.02).

All patients evaluated in terms of age, gender, date, cause of trauma, location of injury, cause of injury, time to hospital admission, VA at first admission and follow-up, ocular trauma score11 (OTS), pediatric ocular trauma score (POTS) (2× (age + zone) – additional pathologies)13, surgical procedures, zone 1, zone 2, zone 3 according to the injury site, VA of the cases at admission, 1st, 3rd and 6th months (Snellen), surgeries performed in this period, additional surgeries (vitrectomy, lensectomy, evisceration, etc.). All open globe injuries are categorized by the open globe classification system into three anatomical zones.4,11 Zone I includes the cornea and limbus, zone II is 5-mm posterior to the limbus, and zone III, which includes the macula and optic nerve, is posterior to zone II. OTS and POTS were calculated for each patient.11,12 The patients were divided into five groups (higher points are presumed to be better prognosis) based on the trauma evaluation score:

Group 1: <45 points.
Group 2: 46–64 points.
Group 3: 65–79 points.
Group 4: 80–89 points.
Group 5: 90–100 points.

Patients with a history of previous eye surgery were excluded from the study. The data obtained in the study were analyzed using the "SPSS (Statistical Package for Social Sciences) for Windows" package program (Version 20.0., IBM Corp. Armonk, NY, USA). Categorical variables were tested with the Kruskal–Wallis Chi-square test. Spearman Rank Correlation were used to evaluate the predictive value of OTS and POTS on the VA outcome after eye injury. A p-value 0.05 was considered statistically significant.

Results

Demographic characteristics of the participants are given in Table 1. Eighty two percent (n=57) were boys, and the mean age was 11±5 years. Of patients, 35 (50.7 %) were injured in their right eye, 34 (49.3 %) patients were injured in their left eye. While there was no statistical difference in terms of the affected eye, the rate of being affected was significantly higher in males (p=0.708 and p= 0.001, respectively).

Table 1. The clinical characteristics and the treatment of pediatric eye injuries

Variables	n*	%
Causes of injury		
Metal	21	30.4
Glass	14	20.3
Wood	14	20.3
Knife	7	10.1
Plastic	6	8.7
Stone	4	5.8
Pencil	2	2.9
Wire	1	1.4
Wound location		
Zone 1	60	87.0
Zone 2	28	40.6
Zone 3	9	13.0
Admission Time	7±9 (hours)	7±9 (hours)
Injury Characteristic		
RAPD	26	37.7
Rupture	4	5.8
Retinal detachment	6	8.7
Endophthalmitis	2	2.9
Perforating	3	4.3
Surgery need and complication		
PPV	12	17.4
Cataract Surgery	18	26.1
Postoperative complication	1	1.4
Follow-up time (mo)	2 ±25	27±25

*Total Number of Patients

Follow-up after the initial presentation was made mainly during the outpatient clinic visits. The mean follow-up period was 27±25 months. Of all cases, 85.5% were admitted to the hospital in the first 24 hours. The earliest admission was two hours and the latest was 74 hours after the trauma. The mean admission time was 7.3 (7 ± 9) hours. The most common reported cause of injury was sharp and piercing tools (65.1%). The most common month of injury was determined as October (18.8 %).

While only zone 1 was affected in 87 % of the cases, zone 2 was affected in 40.6% and zone 3 was affected in 13%. Relative afferent pupil defect (RAPD) was present in 37.7% of the cases. 5.8 % were rupture, 8.7% retinal detachment, 2.9% endophthalmitis, 4.3% perforating injury (Table 1).

While VA could not be evaluated in 7% of the cases at the time of presentation, VA was 0.1 or less in 60%, and 0.1-0.6 in 25.7% and 4.3% had VA better than 0.6. In the sixth month of follow-up, VA could not be evaluated in 2.9% of the cases (inoperable), VA was 0.1 or less in 11.4 %, VA was 0.1-0.6 in 25.7% and better than 0.6 in 60 %. (Figure 1, Table 2).

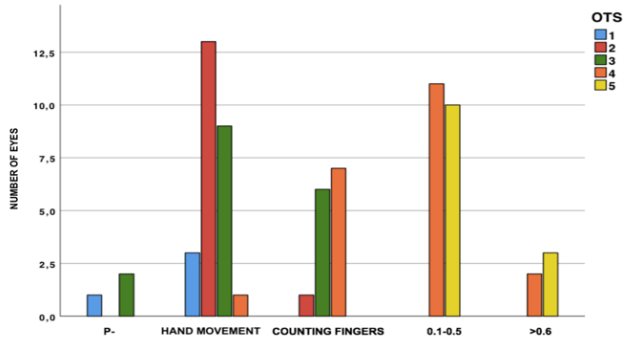

Figure 1: Relationship between baseline visual acuity and ocular trauma score.

Table 2: Initial and last follow-up visual acuity of patients with ocular injury.

Visual Acuity (VA)	Baseline	Last follow-up VA
NLP	3	4
HM (0.001)	26	3
FC (0.001-0.1)	14	13
VA= 0.1 – 0.5	21	49
VA≥0.6	5	69

NLP: No light perception; HM: Hand movement; FC: Finger counting.

Traumatic cataract formation was the most common complication in the postoperative period. In addition to primary repair, 26.1% required lensectomy and 17.4% underwent vitrectomy. Intraocular foreign body was present in 4 cases who underwent vitrectomy. PPV was performed in 4 cases due to endophthalmitis and 2 cases were evaluated as inoperable. In the cases whose VA could be evaluated, 6% had rupture, 10% had RAPD, and 3% had perforation. The most common type of injury was zone 1, and the most common tool was sharps. A statistically significant correlation was found between the affected zone and VA (p=0.009). The affected site of injury was a factor influencing visual prognosis. 17.4% of the cases had PPV, 26.1% had cataract surgery, and postoperative complications developed in 1.4%. (Table 1)

The ocular trauma score was 74 ± 16, and the pediatric ocular trauma score was 64 ± 19. Ocular trauma score correlated moderately with VA at baseline (r=0.687, p<0.001) (Figure 1). Median OTS values of patients with VA >0.1 at baseline were 80 (IQR: 80-90), while patients with <0.1 had OTS values of 60 (IQR: 60-70) (p<0.001) (Figure 2) and OTS moderately correlated with VA during follow-ups (r=0.611, p<0.001). (Figure 3) Correlation values of pediatric ocular trauma score was lower (initial VA and r=0.574, p<0.001). No correlation was found between the time of admission and VA or trauma scores at admission and follow-up.

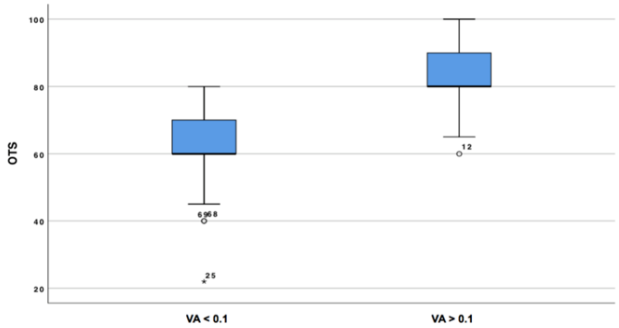

Figure 2: Median OTS values of patients with visual acuity (VA) >0.1 and with <0.1 at baseline

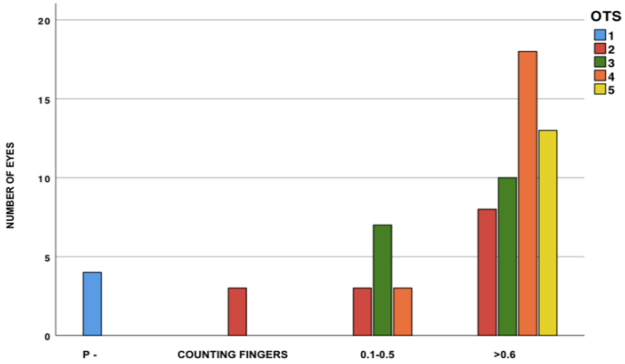

Figure 3: Relationship between last follow-up visual acuity and ocular trauma score (OTS)

Discussion

Ocular penetrating traumas are an important public problem and they cause serious vision loss for the child age group, who will be the future of the country, and increase the health-related financial burden. In addition, open glob injuries that cause serious losses in vision may negatively affect the mental health of the child and family and cause psychological trauma.[1,13-16]

The main purpose here should be examining the causes of trauma, to raise the parents' awareness and the precautions, even if they want to protect their children as much as possible, and thus to prevent trauma. In our retrospective study, the epidemiological factors and risk groups that cause OGI in our region, and the factors affecting the prognosis were evaluated. Our pediatric globe trauma population was similar to other reports. In our study, we found a significantly higher rate of ocular injury in boys than in girls, similar to other studies.[8, 17-21] This significant difference was similar to the gender difference in adults.[22]

This result shows that boys are more open to traumas than girls because they are more active, more free, adventurous and curious. In studies conducted with children, the mean age was 10.3[23], 6.8[12] and, 9.1[21], while the mean age in our study was 11 ± 5 years. It was also consistent with the results of the review study by Li X *et al.*[24] When examined according to injury object, Öztürk *et al.* reported that injuries related to

metallic objects were more frequent.[21] Similarly, in our study, the cause of trauma was predominantly due to penetrating injury of sharp metal objects (30.4%). In terms of injury site, zone 1 injury was the most common with a high rate in our study (87 %)., as in many other studies in the literature.[12,19, 21] When the literature is scanned, many factors that determine the prognosis of penetrating eye injuries have been identified. Visual acuity,[22-27] which is the most important among them, followed by wound site and size,[23-25,29] presence of relative afferent pupillary defect (RAPD),[23-25] mechanism of injury,[23-26] intraocular hemorrhage, lens damage,[23,24] retinal detachment,[25,30] presence of intraocular foreign body and endophthalmitis[26,27,31]. It is known that the closer the wound end is to the posterior, the worse the prognosis is. It is known that vitreous loss leads to retinal detachment even in the absence of retinal damage rather than trauma.[32]

In our study, severe complications such as 8.7% retinal detachment and 2.9% endophthalmitis, that could seriously affect the VA and prognosis were seen in zone 2 and 3 trauma patients. In terms of the management of complications rather than primary surgery, the need for additional surgery was cataract surgery with 26.1% and PPV with 17.4%. In our study, the effects of OTS and POTS on final VA and prognosis were examined, and while both POTS and OTS were effective, the correlation levels of OTS with final VA were found to be higher. It was found to be superior in guessing. We think that this difference may be due to the lack of initial VA data and the difficulty of obtaining/evaluating RAPD data due to restlessness and difficulty in understanding in children, and that the two methods may be similarly effective.

There are a few limitations in the present study. Due to the retrospective design of our study, it may lead to the possibility of losing patients in follow-up and a lack of outcome data in some identified patients. The sample size was relatively small, and it was not a multicenter study. However, we consider our study results are of representative significance, as research was done in the largest ophthalmological hospital of the region, which receives the majority of the pediatric open globe injuries.

Despite the increase in family education, and preventive measures such as advanced anterior segment and vitreoretinal surgical methods and treatment of amblyopia, eye traumas are still serious public problem According to our experience, vision loss resulting from ocular trauma in children is possible to be reduced by taking precautions and following appropriate treatment procedures. It was observed that good VA could be obtained with the surgical interventions of the physicians against the traumas as much as the attention of the families.

In conclusion, even though RAPD cannot be evaluated, OTS is a reliable tool to predict visual prognosis in pediatric open globe injuries. Considering various conditions shaping children's lives and their experiences, adapting these conditions to children gain importance in preventing ocular traumas. Because ocular traumas carry the risk of amblyopia in children, unlike adults.[24]

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Conflict of Interest
The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Author Contributions
DP: Conception and design; SS, KDK: Data collection; SS, DP: Analysis and interpretation of data; DP, SS: Writing the manuscript; DP, SS, KDK: Critical revision of the manuscript

References

1. Abbott J, Shah P. The epidemiology and etiology of pediatric ocular trauma. *Surv Ophthalmol.* 2013;58:476–485.
2. Pizzarello LD. Ocular trauma: time for action. *Ophthalmic Epidemiol*. 1998;5:115–116.
3. Birch EE, Castañeda YS, Cheng-Patel CS, et al. Self-perception of School-aged Children With Amblyopia and Its Association With Reading Speed and Motor Skills. *JAMA Ophthalmol*. 2019;137(2):167-174.
4. Serrano JC, Chalela P, Arias JD. Epidemiology of childhood ocular trauma in a northeastern Colombian region. *Arch Ophthalmol*. 2003;121(10):1439-1445.
5. Al-Mahdi HS, Bener A, Hashim SP. Clinical pattern of pediatric ocular trauma in fast developing country. *Int Emerg Nurs*. 2011;19(4):186-191.
6. Charak R, Ford JD, Modrowski CA, Kerig PK. Polyvictimization, Emotion Dysregulation, Symptoms of Posttraumatic Stress Disorder, and Behavioral Health Problems among Justice-Involved Youth: a Latent Class Analysis. *J Abnorm Child Psychol*. 2019;47(2):287-298.
7. Gupta A, Rahman I, Leatherbarrow B. Open globe injuries in children: factors predictive of a poor final visual acuity. *Eye (Lond)*. 2009;23(3):621-625.
8. Niiranen M, Raivio I. Eye injuries in children. *Br J Ophthalmol*. 1981;65(6):436-438.
9. Oiticica-Barbosa MM, Kasahara N. Eye trauma in children and adolescents: Perspectives from a developing country and validation of the ocular trauma score. *J Trop Pediatr*. 2015;61(4):238-243.
10. Zhu L, Wu Z, Dong F, et al. Two kinds of ocular trauma score for paediatric traumatic cataract in penetrating eye injuries. *Injury*. 2015;46(9):1828-1833.
11. Kuhn F, Maisiak R, Mann L, Mester V, Morris R, Witherspoon CD. The Ocular Trauma Score (OTS). *Ophthalmol Clin North Am*. 2002;15(2):163-vi.
12. Acar U, Tok OY, Acar DE, Burcu A, Ornek F. A new ocular trauma score in pediatric penetrating eye injuries. *Eye (Lond)*. 2011;25(3):370-374.
13. Hoskin AK, Philip SS, Yardley AM, Mackey DA. Eye Injury Prevention for the Pediatric Population. *Asia Pac J Ophthalmol (Phila)*. 2016;5(3):202-211.
14. Lee R, Fredrick D. Pediatric eye injuries due to nonpowder guns in the United States, 2002-2012. *J AAPOS*. 2015;19(2):163-8.e1.
15. Cao H, Li L, Zhang M, Li H. Epidemiology of pediatric ocular trauma in the Chaoshan Region, China, 2001-2010. *PLoS One*. 2013;8(4):e60844.
16. Xue C, Yang LC, Kong YC. Application of pediatric ocular trauma score in pediatric open globe injuries. *Int J Ophthalmol*. 2020;13(7):1097-1101.
17. Nelson LB, Wilson TW, Jeffers JB. Eye injuries in childhood: demography, etiology, and prevention. *Pediatrics*. 1989;84(3):438-441.
18. Lambah P. Some common causes of eye injury in the young. *Lancet*. 1962;2(7270):1351-1353.
19. Cohen E, Antman G, Katzburg E, et al. A modified pediatric ocular trauma score for predicting visual outcome post open globe injury. *Graefes Arch Clin Exp Ophthalmol*. 2022. doi:10.1007/s00417-022-05723-5.

20. Oydanich M, Uppuluri A, Zarbin MA, Bhagat N. Epidemiology of Ocular Injuries Related to Toy Guns in Pediatric Patients From 2000 to 2019. *J Pediatr Ophthalmol Strabismus*. 2022;59(3):e29-e31.
21. Öztürk H, Özen B. The clinical features and the factors affecting visual prognosis in pediatric open-globe ınjuries. *Int Ophthalmol*. 2022. doi:10.1007/s10792-022-02359-6.
22. Yalcin Tök O, Tok L, Eraslan E, Ozkaya D, Ornek F, Bardak Y. Prognostic factors influencing final visual acuity in open globe injuries. *J Trauma*. 2011;71(6):1794-1800.
23. Schörkhuber MM, Wackernagel W, Riedl R, Schneider MR, Wedrich A. Ocular trauma scores in paediatric open globe injuries. *Br J Ophthalmol*. 2014;98(5):664-668.
24. Li X, Zarbin MA, Bhagat N. Pediatric open globe injury: A review of the literature. *J Emerg Trauma Shock*. 2015;8(4):216-223.
25. Sharma A, Kaur R, Kumar S, et al. Fibrin glue versus N-butyl-2-cyanoacrylate in corneal perforations. *Ophthalmology*. 2003;110(2):291-298.
26. Brinton GS, Topping TM, Hyndiuk RA, Aaberg TM, Reeser FH, Abrams GW. Posttraumatic endophthalmitis. *Arch Ophthalmol*. 1984;102(4):547-550.
27. Boldt HC, Pulido JS, Blodi CF, Folk JC, Weingeist TA. Rural endophthalmitis. *Ophthalmology*. 1989;96(12):1722-1726.
28. Affeldt JC, Flynn HW Jr, Forster RK, Mandelbaum S, Clarkson JG, Jarus GD. Microbial endophthalmitis resulting from ocular trauma. *Ophthalmology*. 1987;94(4):407-413.
29. Karlson TA, Klein BE. The incidence of acute hospital-treated eye injuries. *Arch Ophthalmol*. 1986;104(10):1473-1476.
30. Peyman GA, Carroll CP, Raichand M. Prevention and management of traumatic endophthalmitis. *Ophthalmology*. 1980;87(4):320-324.
31. Hamill MB: Management of scleral perforation; in Krachmer JH, Mannis MJ, Holland EJ (eds): *Cornea*, 2nd ed. Philadelphia, Elsevier, 2005 pp 1863–1870.
32. Acar U, Tök ÖY, Acar DE, Burcu A, Örnek F. Epidemiological and Clinical Evaluation of Open-Globe Injuries in Childhood. *Turk J Ophthalmol*. 2010;40:62-66.