



RESEARCH ARTICLE

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Evaluation of Optical Coherence Tomography Alterations in Blunt Ocular Trauma

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Objective: This study aims to reveal the importance of optical coherence tomography (OCT) in diagnosis and follow-up of patients with blunt trauma, as well as its usability as a substantial adjunct to ophthalmological examination.

Materials and Methods: Sixty eyes of 30 patients exposed to blunt ocular trauma were included in this study. In the first ophthalmologic examination, best-corrected visual acuity (BCVA), Intraocular pressures measured by Goldman applanation tonometry, anterior segment and fundus examination were performed. Afterwards, anterior segment and macula were scanned by OCT.

Results: Sixty eyes of 30 patients who were exposed to blunt ocular trauma (24 males, 80%) were enrolled in this study. The eye that was exposed to blunt ocular trauma was chosen to be in the study group, and the other unaffected eye was chosen to be in the control group. BCVA mean values were significantly worse in affected eyes as 0.87 ± 0.39 than in healthy eyes as 0.10 ± 0.15 ($p < 0.001$). Intraocular pressure mean values were significantly higher as 20.2 ± 5.13 in affected eyes than in healthy eyes as 13.4 ± 3.0 ($p < 0.001$). Central corneal thickness (CCT) mean values were significantly higher (594 ± 93.1) in the study group than the control group (542 ± 42.1) ($p < 0.001$). There was no significant difference in terms of macular thickness (221 ± 16.8 in affected eyes and 220 ± 16.8 in healthy eyes) ($p > 0.05$).

Conclusion: In conclusion, OCT is a noninvasive, easily applicable, repeatable tool with high speed and resolution used for diagnosis and follow-up of the ocular trauma patients. OCT should be more preferred by ophthalmologists to reveal undefined alterations in eyes exposed to blunt trauma.

Key Words: Optical coherence tomography (OCT), eye injury, blunt ocular trauma

Künt Oküler Travmada Optik Kohorens Tomografi Değişikliklerinin Değerlendirilmesi

Amaç: Bu çalışma, optik koherens tomografinin (OKT) künt travmalı hastaların tanı ve takibindeki önemini ve oftalmolojik muayeneye önemli bir yardımcı olarak kullanılabilirliğini ortaya koymayı amaçlamaktadır.

Gereç ve Yöntem: Bu çalışmaya künt oküler travmaya maruz kalmış 30 hastanın 60 gözü dahil edildi. Künt oküler travmaya maruz kalan göz çalışma grubuna, hastanın diğer sağlıklı gözü ise kontrol grubuna dahil edildi. İlk oftalmolojik muayenede en iyi düzeltilmiş görme keskinliği (LogMar), göz içi basınçları (goldman aplanasyon tonometrisi), ön segment ve fundus muayenesi yapıldı. Ön segment ve makula OKT ile tarandı.

Bulgular: Künt oküler travmaya maruz kalan 30 hastanın (24 erkek, %80) 60 gözü çalışmaya alındı. En iyi düzeltilmiş görme keskinliği sağlıklı gözlerde 0.10 ± 0.15 bulundu, künt travmadan etkilenen gözlerde ise istatistiksel anlamlı olarak daha kötüydü 0.87 ± 0.39 ($p < 0.001$). Travmadan etkilenen gözlerde göz içi basıncı ortalama değerleri 20.20 ± 5.13 mmHg, sağlıklı gözlerde ise 13.40 ± 3.00 mmHg bulundu ($p < 0.001$). Travmadan etkilenen gözlerde göz içi basıncı istatistiksel olarak daha yüksekti. Santral kornea kalınlığı (SKK) ortalama değerleri etkilenen gözlerde 594 ± 93.10 ve sağlıklı gözlerde 542 ± 42.10 idi ($p < 0.001$). Santral makula kalınlığı (SMK) ortalama değerleri etkilenen gözlerde 221 ± 16.80 , sağlıklı gözlerde 220 ± 16.80 idi ($p > 0.05$). Sonuçta, künt travmaya maruz kalan gözlerde SKK ortalama değerleri yüksek bulundu. Ancak ve travmatik ve travmatik olmayan gözler arasında SMK ortalama değerlerinde anlamlı bir fark bulunmamıştır.

Sonuç: OKT oküler travma hastalarının tanı ve takibinde kullanılan, noninvaziv, kolay uygulanabilir, tekrarlanabilir, yüksek hız ve çözünürlükte bir araçtır. OKT, künt travmaya maruz kalan gözlerde tanımlanamayan değişiklikleri ortaya çıkarmak için daha fazla tercih edilmelidir.

Anahtar Kelimeler: Optik koherens tomografi, göz yaralanması, künt göz travması

Introduction

More than 19 million people are exposed to ophthalmic injuries each year worldwide. Even minor ocular injuries are contributed to morbidity and disability (1). Oner et al. (2) reviewed all the patients who were admitted to the emergency department with eye injuries in two years prospectively and it revealed that half of the patients (48%) had experienced blunt ocular trauma. Blunt ocular trauma can lead to a wide variety of eye structure changes such as traumatic cataract, retinal and choroidal hemorrhage, corneal abrasion, commotio retinae, traumatic hyphema, traumatic iris defects, retinal

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detachment, vitreous hemorrhage, traumatic angle recession, subconjunctival hemorrhage, lens dislocation and subluxation (1,2).

Optical coherence tomography (OCT) is a speed, cross sectional, non-invasive imaging system in biological systems and commonly preferred in clinical practice for detailed examination of posterior and anterior segment injuries. OCT was first revealed as a new imaging system in 1991 by Huang et al. (3) Although OCT was first used to evaluate the posterior segment, after the addition of the anterior segment module ophthalmologists were able to assess detailed images of anterior segment in 2008 (3-5).

This study aims to reveal the importance of OCT in diagnosis and follow-up of the patients with ocular blunt trauma, as well as its usability as a substantial adjunct to ophthalmological examination.

Materials and Methods

Research and Publication Ethics: This observational, prospective study adhered to the tenets of Declaration of Helsinki and approved by the Local Ethics Committee of İzmir Tepecik Training and Research Hospital (meeting number:19, decision number: 9, 15 March 2016). Written informed patient consent was obtained from all patients included in this study. The study was conducted between January 2015 and February 2016.

The patients who were admitted to İzmir Tepecik Training and Research Hospital Emergency Department within the first three days of experiencing blunt eye trauma were included to this study. We have evaluated the structural changes that observed in both anterior and posterior segment due to ocular blunt trauma with the help of OCT. Sixty eyes of 30 patients were enrolled. The eye which was exposed to ocular blunt trauma was included to the study group and the other healthy eye was included to the control group.

Exclusion criteria were the presence of any other ocular disease; history of any eye surgery, injections or laser treatment, exposure of bilateral eyes to the blunt ocular trauma. Healthy eyes of the patients that were not exposed to the trauma were considered as the control group.

The best-corrected visual acuity (BCVA) of the patients was assessed with using LogMAR (Reichertcompany, Reichert, INC, NY, USA) for the statistical analysis at the initial examination. Intraocular pressures were assessed with Goldmann applanation tonometer. Fundus and anterior segment examination was performed using slit lamp biomicroscope in detail. Structural changes of anterior and posterior segment were recorded with OCT. The anterior segment OCT was performed through the corneal center. Macular OCT was performed as early as possible in case corneal edema may not allow the detailed examination. Same investigator performed the evaluations and measurements. BCVA, macular thickness, central corneal thickness, and intraocular pressures of the

uninjured and injured eyes of the patients were compared.

The SPSS 17.0 statistical package program was performed in all analyses and at 95% confidence level ($p < 0.05$ was considered statistically significant). The relationship between the two categorical variables was analyzed with the non-parametric Chi-square. Categorical variables were calculated as the mean and standard deviation. The two independent sample averages' difference was evaluated with the Student's t-test. The numerical variables' normal distribution fit was calculated with the Shapiro Wilk test.

Results

Sixty eyes of 30 patients were enrolled. Mean age was 29.7 ± 18.5 years (range 9-68 years) in this study. Six (20%) were female and 24 (80%) patients were male.

Only one eyes of the participants were exposed to ocular blunt trauma. Two (6.7%) patients had corneal lamellar laceration, three (10%) patients had commotio retinae and eight (26.7%) patients had traumatic hyphema (Table 1). None of these diagnosis were simultaneous.

The causations of injuries were as follows; 33% ($n=10$) punch on the eye, 30% ($n=9$) traffic accident, 23% ($n=7$) falling down from height, 13% ($n=4$) eye injury caused by bottle cap (Table 2).

Table 1. Demographic characteristics

	Total (n=30)
Age, Mean$\pm$SD (Min-Max)	29.70 $\pm$ 18.50 (9-68)
Gender (n, %)	
Male	24 (80%)
Female	6 (20%)
Diagnose (n, %)	
Commotio retina	3 (10%)
Epithelial defect	8 (26.7%)
Traumatic hyphema	17 (56.6%)
Corneal lamellar laceration	2 (6.7%)

Table 2. Etiology of injuries

Etiology	(n) %
Punch	33% (n=10)
Traffic accident	30% (n=9)
Fall	23% (n=7)
Bottle cap hit	13% (n=4)

BCVA were 0.87 ± 0.39 in the study group and 0.10 ± 0.15 in the control group. Visual acuity decrease was statistically significant in the study group ($p < 0.001$). Intraocular pressure mean values in the uninjured eyes were 13.40 ± 3.00 mmHg, and in the injured eyes were

20.20±5.13 mmHg. Intraocular pressure increase in the injured eyes was statistically significant ($p<0.001$). The mean corneal thickness values were 594±93.10 µm in injured eyes, and 542±42.10 µm in uninjured eyes. Central corneal thickness of injured eyes were significantly thicker ($p=0.011$). The mean values of central macular thickness were 221±16.80 µm in injured eyes, and 220±16.80 µm in uninjured eyes. The difference between the macular thickness mean values of the two groups was not statistically significant. ($p=0.767$, Table 3)

17 patients (56.6%) were diagnosed with traumatic hyphema. Eight patients diagnosed with traumatic

hyphema who had morphological changes at retina layers also had significant vision loss. These structural changes are as follow. Five of traumatic hyphema patients had irregular inner segment/outer segment (IS/OS) junction in the macula OCT (Figure 1). One of these eight patients had retinal ondulation and separation between Bruch's membrane and retina pigment epithelium (RPE) (Figure 2). While in another patient photoreceptor outer segment hyperreflectivity was detected (Figure 3). RPE separation at the inferior temporal fovea was observed in another patient (Figure 4).

Table 3. Comparison of measurements in affected and nonaffected eyes

Parameters	Affected Eyes (n=30) Mean±SD	Nonaffected Eyes (n=30)	<i>p</i>
Vision	0.87±0.39	0.10±0.15	<0.001
Intraocular pressure (mmHg)	20.20± 5.13	13.40±3.00	<0.001
Corneal thickness (µ)	594±93.10	542±42.10	0.011
Macular thickness (µ)	221±16.80	220±16.80	0.767

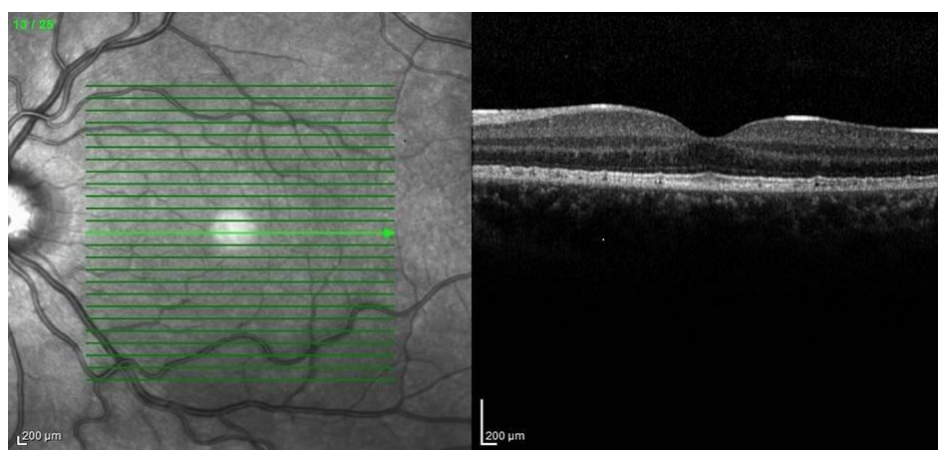


Figure 1. Irregularity in IS/OS junction in macula OCT image

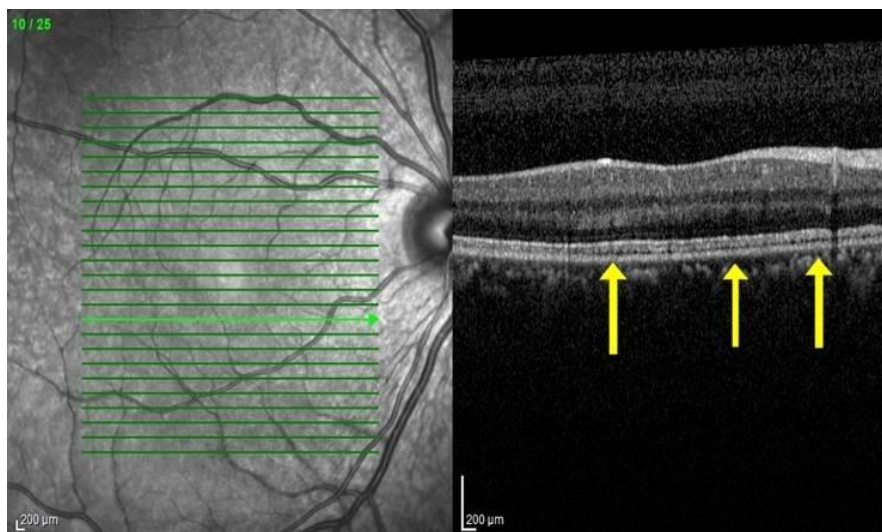


Figure 2. The separation between Bruch's membrane and retinal pigment epithelium layers are shown in macula OCT image

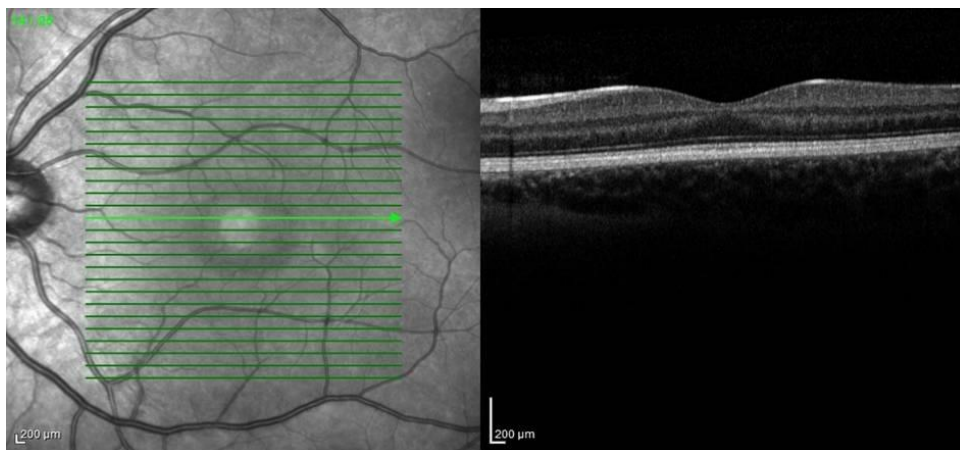


Figure 3. Hyperreflectivity in photoreceptor outer segment is shown in macula OCT image

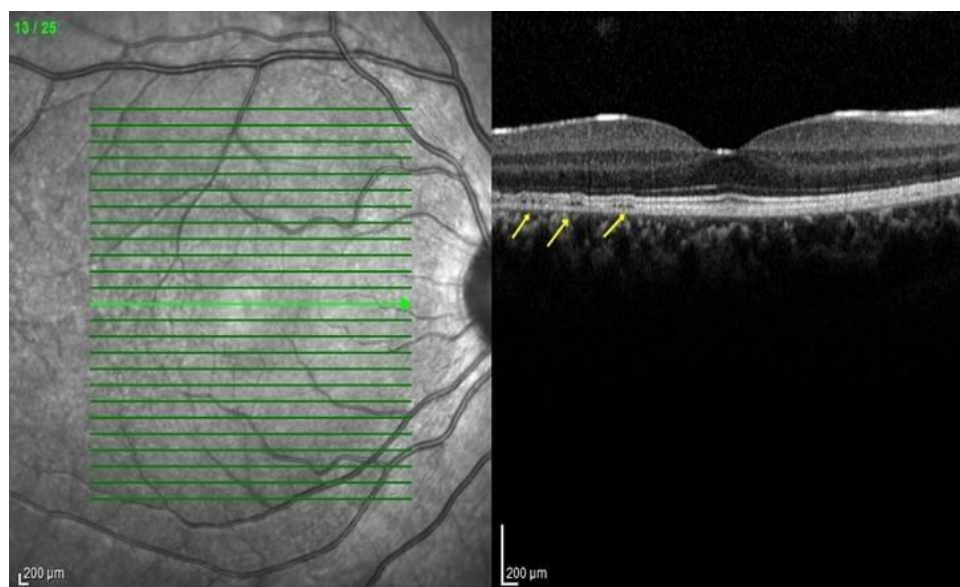


Figure 4. Separation of the retinal pigment epithelium at the inferior temporal fovea is detected in macula OCT image

Three patients (10%) were diagnosed with commotio retinae and two of them had no structural changes in the macula OCT. While one of the commotio retinae patients had irregular IS/OS junction.

Discussion

Ocular blunt trauma is a leading cause of preventable visual impairment and blindness worldwide. The most common form of ophthalmic trauma is blunt ocular trauma. The enforcement on the ocular surface is transferred to the posterior segment and results in retinal complications (5).

Adolescents and children are the most affected group by blunt ocular trauma (6). In this study male rate was 80% and 72% of the participants were between 11-17 years of age. This is because men spend more time than women in both business and social life, as a result trauma risk increases for young men who spend more time outside.

Blunt ocular trauma has four phases are overshooting, compression, decompression and oscillations (7,8). Anterior segment is often more affected compared to posterior segment and hyphema is one of the most common pathologic findings of blunt ocular trauma (9). Traumatic hyphema is represented with the sudden vision loss and ophthalmologists often encounter. If complications develop during follow-up or patients have inadequate treatment, visual prognosis may worsen. Visual loss may be the cause of the amblyopia in children and the loss of work in adults (9-11). The most common diagnosis due to blunt ocular trauma was traumatic hyphema in this study (56.6% n=17). The other diagnoses were corneal lamellar laceration, commotio retinae and corneal epithelial defect. Eight patients who were diagnosed with traumatic hyphema had retinal structural alterations in macular OCT. In addition, none of the patients had permanent blindness.

At first, ophthalmologists were able to examine only posterior segment by OCT, then 1310 nanometer wavelengths was used and let the anterior segment to be evaluated. With the help of AS-OCT (anterior segment-OCT) lesions that can not be detected by the ophthalmologic examination can be revealed in blunt globe trauma patients. AS-OCT is a robust tool to diagnose the injury of ocular surface of traumatic eyes (7-10). In this study, central corneal thickness was evaluated with AS-OCT. A significant increase was found in central corneal thickness in injured eyes compared to uninjured eyes. Increase of corneal thickness was detected in patients with clinically undiagnosed corneal edema. Corneal edema may result with permanent vision decrease, so diagnosis is important.

OCT is a noninvasive tool with high resolution and speed that can be used to diagnose the alterations due to macular trauma. The structural changes which were not detectable by the clinician's examination can be assessed with the addition of OCT to routine

ophthalmologic examination (11). In this study, the retina-choroidal junction, retinal layers and central macular thickness, were examined in the posterior segment. In recent studies, macular thickness and retinal volume of injured did not differ from uninjured eyes significantly after trauma (7). In accordance with this result, no significant difference was detected in central macular thickness as a result of blunt ocular trauma.

The commotio retinae (Berlin's edema) is often related to blunt eye trauma. The characteristic sign is retinal opacification which usually subsides in a short period (12-15). Damage to the outer layer of the photoreceptors and retinal pigment epithelium are the possible causes of this opacification. Retinal pigment epithelium and retinal photoreceptor outer segment damage is often observed in OCT images of patients in commotio retinae (13, 14). In recent studies, transient hyperreflectivity of outer retina that is contributed to mild lesions with better visual prognosis and destruction of inner/outer segment junction (IS/OS), hyperreflectivity of overlying retina were observed that is contributed to severe lesions at the OCT images in commotio retinae (11-16). In this study, we detected structural retinal layer alterations in eight patients. One of these eight patients was diagnosed as commotio retinae with fundus examination and had irregular IS/OS junction. Overall, if commotio retinae is the only retinopathy diagnosed during the fundus examination, OCT reveals normal retinal structures or transient abnormalities which are often detected at the RPE complex and IS/OS. OCT may reveal the baseline photoreceptor disruption and ophthalmologists may predict visual outcomes during the follow-up of commotio retinae patients.

All of the patients with pathological morphological retinal fiber layers also had traumatic hyphema, which may be related to the severity of the trauma.

Outcomes of this study have shown that OCT scan was able to reveal retinal damage in ocular trauma patients who did not show evident commotio retinae findings in fundus exam.

This study has some limitations. First of all there was small sample size to conclude concrete suggestions. However, it was consistently observed that there are pathological retinal layer changes in patients with significant vision loss and blunt ocular trauma. Secondly, uninjured eyes in same patients were assigned as control group. However, individual characteristics and differences of patients may effect statistical results and we believe this possible effect would be averted by our method. Thirdly, patients' follow-up records are not present so we long-term contribution of using OCT in trauma patients could not be evaluated.

In conclusion, OCT is a noninvasive, easily applicable, repeatable tool with high speed and resolution used for diagnosis and follow-up of the trauma patients. OCT should be more preferred by ophthalmologists to reveal undefined alterations in eyes exposed to blunt trauma.

Declaration of Interests: The authors have no conflict of interest to declare.

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Reference

1. Guly M, Guly HR, Boumara O, Gray RH, Lacky FE. Ocular injuries in patients with major trauma. *Emerg Med J* 2006;23:915-917
2. Oner A, Kekec Z, Karakucuk S, Ikizceli I, Sözüer EM. Ocular trauma in Turkey: A 2 year prospective study. *Adv Ther* 2006;23:274-283.
3. Huang D, Swanson EA, Lin CP. Optical coherence tomography. *Science* 1991;254:1178-1181.
4. Katkar RA, Tadinada SA, Amaechi BT, Fried D. Optical Coherence Tomography. *Dent Clin North Am* 2018;62:421-4345.
5. Kuhn F, Morris R, Witherspoon CD, Mann L. Epidemiology of blinding trauma in the United States Eye Injury Registry. *Ophthalmic Epidemiol* 2006;13:209-216.
6. Ustaoglu M, Karapapak M, Tiryaki S, et. al. Demographic characteristics and visual outcomes of open globe injuries in a tertiary hospital in Istanbul, Turkey. *Eur J Trauma Emerg Surg* 2020;46:549-556.
7. Oh J, Jung JH, Moon SW, et al. Commotio retinae with spectral-domain optical coherence tomography. *Retina* 2011;31:2044-2049.
8. Huang J, Liu X, Wu Z, et al. Classification of full-thickness traumatic macular holes by optical coherence tomography. *Retina* 2009;29:340-348.
9. Özer Ö, Tuncer ML. Blunt Eye Trauma: Epidemiology, prognostic factors and visual outcome-a 10-year retrospective study. *J Craniofac Surg* 2023;34:36-38.
10. Filemonowicz-Skoczek A, Romanowska-Dixon B. The use of anterior segment optical coherence tomography (AS-OCT) in the imaging diagnostics of intracorneal foreign bodies. *Folia Med Cracov* 2024;64:23-29.
11. Wylegala E, Dobrowolski D, Nowińska A, Tarnawska D. Anterior segment optical coherence tomography in eye injuries. *Graefes Arch Clin Exp Ophthalmol.* 2009; 247(4):451-455.
12. Ahn SJ, Woo SJ, Kim KE, Jo DH, Ahn J, Park KH. Optical coherence tomography morphologic grading of macular commotio retinae and its association with anatomic and visual outcomes. *Am J Ophthalmol* 2013;156:994-1001.
13. Mansour AM, Gren WR, Hogge C. Histopathology of commotio retinae. *Retina* 1992;12:24-28.
14. Sony P, Venkatesh P, Gadaginamath S, Garg SP. Optical coherence tomography findings in commotio retinae. *Clin Experiment Ophthalmol* 2006;346:621-3.
15. El Matri L, Chebil A, Kort F, Bouraoui R, Lagueche L, Mghaieth F. Optical coherence tomography findings in Berlin's edema. *J Ophthalmic Vis Res.* 2010;52:127-9.
16. Itakura H, Kishi S. Restored photoreceptor outer segment in commotio retinae. *Ophthalmic Surg Lasers Imaging* 2011;42:29-31.