Brief communication (Original)

Severe blunt eye trauma causes a decrease in central macular thickness within first 48 hours of trauma

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Background: Blunt eye trauma is an important emergency in ophthalmology practice, and may alter the structure of the macula.

Objectives: To evaluate the optic coherence tomography (OCT) measurements of central macular thickness (CMT) among patients admitted to the hospital within 48 hours of blunt eye trauma.

Methods: Prospective cross-sectional study to evaluate patients who were admitted to hospital with blunt eye trauma within 48 hours trauma. Spectral domain OCT was used to measure macular thickness. CMT measurements of 24 healthy and 26 traumatized eyes of same patients were analyzed as control and case groups, respectively.

Results: The mean CMT measurements were $230.04 \pm 18.64 \mu\text{m}$ in control and $226.50 \pm 18.89 \mu\text{m}$ in traumatized groups. The difference between two groups was not statistically significant ($P = 0.412$). However, when the patients were classified according to the severity of trauma, CMT measurements of severely injured patients were found significantly lower than both healthy and mildly traumatized eyes ($P = 0.008$, $P = 0.004$, respectively).

Conclusions: Early stage macular OCT findings at blunt eye trauma may change with the severity of trauma. We have determined an insignificant increase in the mildly traumatized group in CMT compared with the healthy group within the first 48 hours of blunt trauma as a sign of macular trauma. However, in the severely traumatized group in CMT values significantly decreased, which may be a sign of cellular loss. Further prospective studies with long follow-up periods are warranted to elucidate the effects of this decrease in thickness.

Keywords: Macular edema, optical coherence tomography, trauma

Blunt eye trauma may occur in different ways and constitutes an important emergency in ophthalmology practice. Patients are usually admitted to the hospital within 48 hours of trauma. Blurred vision because of blunt eye trauma can occur because of different reasons, such as macular edema, retinal hemorrhages, or traumatic optic neuropathy [1]. Macular edema, which is also known as the Berlin edema, is the retinal opacification as a result of damage to the retinal pigmented epithelium and photoreceptor outer segments and subsequent permanent loss of these photoreceptors [2-4].

Macular edema can be seen subjectively as pallor on funduscopic examination and photography [5]. A relatively new method for examination of the retina is optical coherence tomography (OCT), which shows

delicate images comparable to histological sections [6, 7]. Optical coherence tomography is a valuable, noninvasive tool for imaging macular trauma because it provides detailed images of the anatomical structures of the eye and enables the monitoring of various pathological changes, particularly in acute traumatic maculopathy [8]. Recently, there are some retrospective studies presenting late stage OCT findings of traumatic macular edema [9, 10]; however, to our knowledge, data regarding the early macular findings within the first 48 h of blunt eye trauma are limited. In this prospective study, we aimed to evaluate the OCT measurements of central macular thickness (CMT) among patients admitted to hospital within 48 hours of blunt eye trauma.

Materials and methods

This prospective cross-sectional study was designed to evaluate the patients who were admitted to hospital with complaint of blunt eye trauma within

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48 hours of trauma between January 2014 and April 2014. Researchers complied with the ethical principles of the contemporary Declaration of Helsinki. Ethical approval was provided by the research ethics committee of Bagcilar Education and Research Hospital (approval no. 2014/187). Written informed consent was obtained from all patients for their participation in the study, or their parents or legal guardians if not capable of giving consent. Demographic data and causes of trauma were recorded appropriately. Patients were not included if they had any other ocular pathology, opacities, preretinal, retinal or subretinal hemorrhages, or macular holes. Routine ophthalmologic examinations including best-corrected visual acuity (BCVA) testing with Snellen chart, intraocular pressure measurements, biomicroscopic, and funduscopy examinations were performed on all participants. Snellen measurements were converted to logarithm of the minimal angle of resolution (logMAR) for statistical purposes [11]. Additional diagnostic tests such as tomography were conducted when indicated. Spectral domain OCT (RS-3000, Nidek, Gamagori, Aichi, Japan) was used for the CMT measurements.

CMT measurements of healthy and traumatized eyes were analyzed as control and case groups, respectively. In determining CMT, the central macular region from the internal limiting membrane to Bruch's membrane were measured. Severity of trauma was classified according to clinical findings. All measurements were conducted by the same examiner (KA).

Statistical analysis

Data entry and analysis were performed using the Statistical Package for Social Sciences, version 17 (SPSS Inc, Chicago, IL, USA). Mann–Whitney *U* and Kruskal–Wallis tests were used for comparison of means. $P < 0.05$ was regarded as statistically significant.

Results

We included 24 patient participants who were injured in one eye and one patient was injured in both eyes. In all, 26 eyes were included in the traumatized group, while 24 healthy eyes of the participants were included in the control group. The mean age ($\pm$ standard deviation, SD) of the controls was 29.9 ± 16.75 years and traumatized patients was 29.1 ± 16.34 years. There were 7 female patients in both groups, but 17 eyes of

the control group belonged to male patients, while 19 eyes of the traumatized group were male eyes. There was no significant difference in age or sex between the control and traumatized groups. There were different kinds of traumas and the most common was battering ($n = 11$, 42%) (**Table 1**).

Clinical findings were used for grouping patients according to the degree of severity of trauma. Patients having hematoma with or without orbital wall fracture were grouped as severely damaged ($n = 11$; 42%); while patients having lid edema with or without ecchymosis and conjunctival hemorrhage were grouped as mildly damaged ($n = 15$; 58%). The mean BCVA of the control group was 0.0167 ± 0.063 , while the mean BCVA of the traumatized group was 0.069 ± 0.1 . One patient whose BCVA was 0.3 at both eyes was amblyopic with hyperopia. The difference in mean BCVA values between 2 groups was statistically significant ($P = 0.03$). The mean CMT was 230.0 ± 18.64 mm and 226.5 ± 18.89 mm at control and traumatized groups, respectively with a range of 196 and 275 mm for both of the groups. There was no significant difference in CMT between two groups ($P = 0.41$). In subgroup analysis; when the mildly traumatized group was compared with the healthy group, there was no significant difference ($P = 0.36$). In the severely injured group, comparison with the healthy group and mildly traumatized group; CMT was significantly reduced ($P = 0.008$ and $P = 0.004$, respectively) (**Figure 1**).

When the CMT values of male and female patients were compared separately; the mean CMT of the female patients was 227.9 ± 10.20 mm in the control group and 226.6 ± 15.71 mm in the traumatized group, and the difference was not significant between the groups ($P = 0.95$). Similarly, the mean CMT of the men was 230.9 ± 21.39 mm in the control group and 226.5 ± 20.33 mm in the traumatized group, and the difference between the groups was not significant ($P = 0.38$).

Tables 1. Causes of blunt eye trauma

Causes of trauma	Frequency (n)	Percent (%)
Battering	11	44
Crash	3	12
Falling	3	12
Brush crash	2	8
Traffic accident	2	8
Punch	2	8
Ball crash	1	4
Iron object crash	1	4
Total	26	100

Figure 1. Boxplots showing the median (line) central macular thickness among healthy (healthy, $n = 24$), mildly traumatized (mild, $n = 13$), and severely traumatized (severe, $n = 13$) groups. Box boundaries indicate 25th and 75th percentiles and whiskers indicate 5th and 95th percentiles. Outliers are shown as solid circles.

Discussion

In this study, we evaluated the CMT of eyes by OCT within 48 hours of blunt trauma. We determined that, although there was no significant difference between healthy eyes and mildly traumatized eyes; severely traumatized eyes had a significantly decreased CMT compared with healthy and mildly traumatized eyes. Because macular edema is expected after blunt eye trauma, this is an interesting finding.

Macular edema (also named Berlin edema or commotio retina if it is associated with trauma) is a well-known condition occurring because of several conditions including trauma [9, 12]. It may be restricted to the macula or involve areas of the peripheral retina [13]. Previously, macular findings after trauma were described as ranging from mild pallor to macular hole formation [14, 15]. Based on histopathological findings from the eyes of human cadavers, investigators showed that the major site of injury in commotio retinae is likely at the photoreceptor outer segmented-retinal pigmented epithelial junction [16]. Depending on the severity of the trauma, areas of disruption of the inner–outer segment junction, hyperreflectivity of the overlying retina, pigment disorders, and retinal atrophy may be seen histopathologically [17]. Not every patient admitted with ocular trauma may show significant funduscopic findings at routine examinations, but OCT images may show macular changes comparable to histological sections [18]. Thus, we have included every patient with blunt eye trauma whether they have any pallor at the macula or not. Nevertheless, we also find no difference between healthy and traumatized

groups. This may be the result of the small sample size, but is nevertheless consistent with previous reports [19]. Although insignificant, as expected, an increase in CMT was reported in mild cases compared with the healthy group as a sign of macular edema. However, we find a significantly decreased CMT measurement when the severity of the trauma increased. This finding is interesting because we expected the development of macular edema. Patients with mild cases of commotio retina present transient visual loss and recover spontaneously, but more severe cases may be associated with permanent visual loss [10, 15]. The decrease in CMT in severe cases may be associated with the cellular loss and may be associated with a worse prognosis that should be studied further.

Data regarding CMT changes in early periods of blunt trauma are limited. Oh et al. retrospectively studied 14 eyes of 14 patients who had experienced blunt ocular trauma and underwent spectral-domain OCT on the same day. In that study 7 eyes had commotio retinae involving the macula and 7 eyes were without it. They reported that macular thickness and volume were not different between eyes with and without commotio retinae involving the macula [20]. In another retrospective case series, Saleh et al. examined 20 patients with blunt eye trauma at presentation, 1 week, and 6 months with OCT. They reported that in all cases, initial OCT revealed an increase in reflectivity of the inner and outer segment junction, with an apposition of the latter to the retinal pigmented epithelium, which were back to normal after one week [21]. Pham et al. and El Matri et al.

reported thickening of the outer retinal structures and increased reflectivity in the outer photoreceptor segments as an OCT finding in their cases of acute traumatic maculopathy [22, 23]. Oladiwura et al. reported that initial OCT findings revealed outer photoreceptor segment disruption, retinal pigment epithelium interdigitation with some outer and inner segment foveal disruption, and intraretinal edema in the outer nuclear layer. Fortunately, follow-up OCT revealed almost complete resolution [24]. However, to our knowledge, cases were not subgrouped as mild or severe before to compare the CMT with OCT.

Although blunt eye trauma is one of the most common complaints of patients seen in emergency clinics, it was not until recently being investigated by sophisticated techniques such as OCT [15]. OCT can be a useful tool in the diagnosis and follow-up of eyes with Berlin's edema and may reveal ultrastructural macular changes because it enables clinicians to reliably detect and measure small changes in macular thickness and to evaluate the efficacy of different therapeutic modalities quantitatively [25].

There are some limitations in this study. Small sample size of the patient participants does not allow us to reach more generally applicable conclusions. OCT and other diagnostic tests such as multifocal electroretinograms may be used together for more precise functional results. Lastly, we did not record the long-term follow-up results of patients after blunt trauma because the aim of this study was restricted to findings in the first 48 hours.

Conclusion

Early stage macular OCT findings at blunt eye trauma may change with the severity of trauma. We have determined an insignificant increase in the mildly traumatized group in CMT compared with the healthy group within the first 48 hours of blunt trauma as a sign of macular trauma. However, in the severely traumatized group in CMT values significantly decreased, which may be a sign of cellular loss. Further prospective studies with long follow-up periods are warranted to elucidate the effects of these findings and their prognostic significance.

Conflicts of interest statement

No authors who participated in this research received any specific grant from any funding agency in the public, commercial, or not-for-profit sectors, and no author declares any conflict of interest.

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