SOLAR MACULOPATHY AFTER WATCHING A PARTIAL SOLAR ECLIPSE

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SUMMARY

Aim: To describe clinical findings in patients with sudden decrease of visual functions according to the solar maculopathy appearance after watching the partial solar eclipse and results of the changes' follow-up after 7 weeks.
Material and Methods: Medical records of five women (6 eyes) with solar maculopathy associated with watching partial solar eclipse on March 20th, 2015 were retrospectively evaluated. The diagnosis of solar maculopathy was established according to the medical history, ophthalmologic examination of the fundus in artificial mydriasis, and confirmed by means of spectral domain optic coherence tomography examination of the macula. The follow-up period of the patients in the study group was 7 weeks.
Results: All patients described the presence of relative central scotoma and decrease of the central visual acuity (VA) of different extension in the involved eye. The average best-corrected visual acuity (BCVA) of women in our group was 6/9 (range, 6/6 partially – 6/18). In one patient, the involvement was bilateral, in the other cases the involvement was unilateral. The biomicroscopic examination of the fundus revealed yellowish to yellow-whitish lesions with brightness of the pigment layer in the center of the foveola in all patients. The optic coherence tomography examination of the macula confirmed the irregularities of the retinal pigment layer and photoreceptors outer segment with hyper-reflective focus of the neuroretina in the center of the foveola.
Conclusion: During the follow-up period, we recorded improvement of the central visual acuity in all women with unilateral involvement. In the woman with bilateral retinal involvement, the best-corrected visual acuity of the right eye remains without any improvement. The optic coherence tomography examination after 7 weeks shows regression of the findings in three eyes. In all other cases, slight structural changes in the center of the macula persist.

Key words: solar maculopathy, solar eclipse, spectral domain optic coherence tomography (OCT)

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INTRODUCTION

Solar maculopathy occurs as a consequence of a phototoxic (photochemical) reaction generated by the effect of sunlight on the retina. In the literature we may also encounter a designation of an affliction of the retina by the effect of solar radiation also under the terms of solar retinopathy or foveomacular retinitis [5]. Solar radiation is applied in the pathophysiology of this affliction, which is directly absorbed by the retinal pigment epithelium (RPE). The subsequent damage to the RPE results in impairment of the intercellular connections of the outer segments of the photoreceptors, which in its final consequence leads to damage thereto [16]. A healthy eye can tolerate fleeting glances at the sun without any consequences, but exposure to solar radiation for a period of 30 seconds or more may cause permanent damage to the macula [17]. In addition to cases of watching the sun during the course of a solar eclipse, damage to the retina occurs also in individuals who have watched the sun for ritual or religious reasons, or under the influence of psychotropic substances such as amphetamines or lysergic acid diethylamide (LSD) [19]. A further group of patients may be people with a mental disorder [2]. Younger patients with transparent optic media are more susceptible to the effect of solar radiation [6].

The first symptoms of affliction of the retina appear in the first four hours after exposure to direct solar radiation [9]. Afflicted patients most frequently complain of the presence of central scotoma, deterioration of central visual acuity of varying degrees, from slight reduction to movement in front of the eye with correct light projection, metamorphopsia or erythropsia [10]. The prognosis is generally favourable, within a few weeks to months central visual acuity returns to its original condition in the majority of patients [5, 8]. However, in a certain proportion of those afflicted, progressive atrophy of RPE in the centre of the macula or the formation of an outer lamellar macular hole may occur, with an irreversible deterioration of visual acuity [4].

The objective of the submitted report is to describe the clinical in patients with a sudden reduction of visual functions as a consequence of solar maculopathy after watching a partial solar eclipse.

METHOD

The healthcare documentation of five women with a diagnosis of solar maculopathy observed at the Department of Ophthalmology at the University Hospital in Ostrava was evaluated retrospectively. The average age of the patients in our cohort was 25 years (median 22 years, interval 16 – 37 years). The cohort included all the patients with affliction of the retina who had watched a partial solar eclipse on 20 March 2015. None of the women had been seriously ill in the period before affliction, all were without long-term medication, with a negative allergological, epidemiological and ocular anamnesis.

Distance visual acuity (non-corrected visual acuity – UCVA and best corrected visual acuity – BCVA) were assessed in all patients on Snellen's optotpyes. In all the patients objective refraction was determined on an auto kerato-refractometer (Auto Ref / Kerato / Tonometer TONOREF II, Nidek). Examination of the ocular fundus was performed biomicroscopically in artificial mydriasis (tropicamidum 1% gtt.) using an indirect lens (VOLK 60 – 90 D). Photographic documentation of the finding on the fundus in mydriasis was performed on all the patients (FF 450 plus IR fundus camera, Zeiss). An examination by optical coherence tomography with spectral domain (SD- OCT, Heidelberg Engineering) was performed for an evaluation of the structural affliction of the retina.

RESULTS

In all the women the cause of retinal damage was careless and inadequately protected observation of a partial solar eclipse. All the patients subjectively described the presence of relative central scotoma and deterioration of central visual acuity developing within the first 5 hours (interval 2 – 5 hours) after exposure to solar radiation. One of the patients subjectively complained of slight pain in both eyes of a non-specific character. Average BCVA in the affected eye in the women in our group was 6/9 at the first eye examination (interval 6/6 – 6/18). In one patient the affliction was bilateral, in the remaining cases this concerned unilateral affliction of the dominant eye. The right and left eyes were represented in an equal ratio. Brief demographic and clinical characteristics of the women in our group of cases is summarised in the table below [table 1].

The outer segments of the affected eyes, including the pupil reactions to illumination, were without a pathological finding in all cases. A biomicroscopic examination of the ocular fundus in artificial mydriasis detected yellowish to yellowish-white lesions with clarification of the pigment layer in the centre of the foveola in all patients [fig. 1a]. A subsequent structural examination of the retina by SD - OCT detected a preserved foveolar contour, irregularities of the retinal pigment epithelium and the outer segments of the photoreceptors, with a hyperreflective deposit of the neuroretina in the centre of the foveola. In two patients accompanying hyporeflective areas were present on the level of the RPE [fig. 2a].

The patients were only observed, no therapy was applied. During the observation period we recorded an improvement of central visual acuity in all the women with unilateral affliction, even despite subjectively stated continual presence of relative central scotoma. In the patient with bilateral injury to the retina, reduced central visual acuity persisted in the right (dominant) eye, whereas in the left (non-dominant) eye there was a complete correction of BCVA and a reduction of the scope of relative central scotoma [table 2]. A biomicroscopic examination in artificial mydriasis seven weeks after exposure demonstrated a complete regression of the deposit changes on the retina in all the women [fig. 1b]. At a follow-up SD – OCT examination we recorded a complete regression of the deposit changes of the retina also from a structural perspective in 3 eyes [fig. 2b]. In a further 3 cases there are evident persisting minor changes in the layer of the RPE [fig. 3a, 3b].

Table 1: Brief demographic and clinical characteristics – of five women with solar maculopathy after watching a solar eclipse. (BCVA – best corrected visual acuity, RE – right eye, LE – left eye, RLE – both eyes).

TABLE 1						
PATIENT	AGE	SUBJECTIVE COMPLAINTS	LATERALITY	INITIAL BCVA (affected eye)	SUBJECTIVE TIME EXPOSURE (seconds)	PROTECTIVE EQUIPMENT USED
woman 1	16	pain, blurred vision, central scotoma	OS	6/12	60	none
woman 2	20	central scotoma, blurred vision, metamorphopsia	OD	6/6 slabě	10	none
woman 3	22	blurred vision, central scotoma	OD	6.12	120	welding slide
woman 4	32	central scotoma	OS	6/18 slabě	60	floppy disk
woman 5	37	bilaterally blurred vision, central scotoma	ODS	6/9 ; 6/6	60	sunglasses

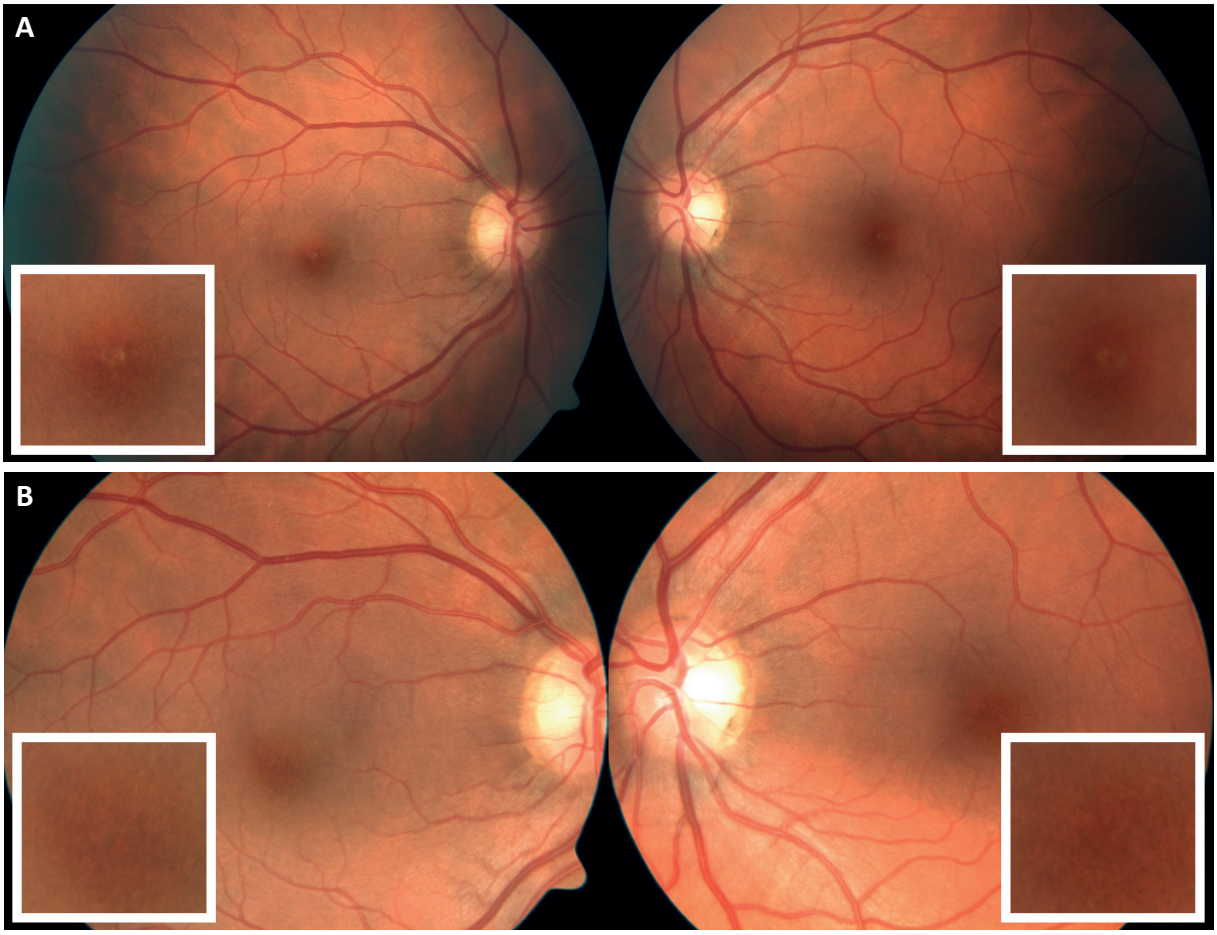

Fig. 1a: Photograph of fundus in acute phase of solar maculopathy - patient 5
Fig. 1b: Photograph of fundus 7 weeks after exposure - patient 5

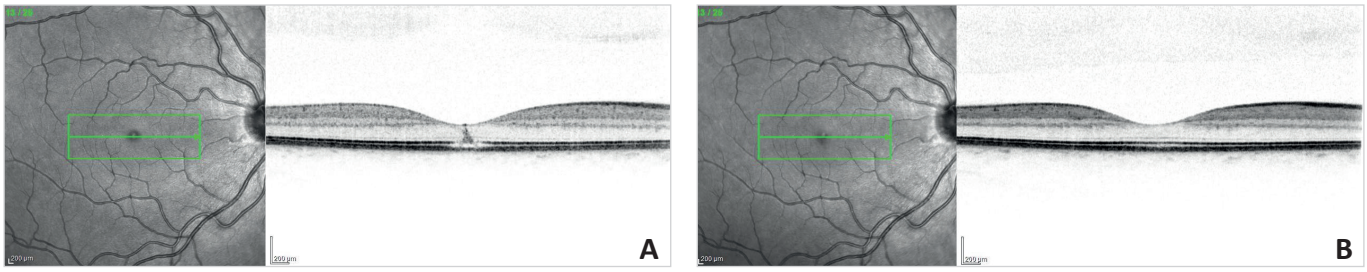

Fig. 2a: OCT examination in acute phase of solar maculopathy – Changes typical of solar maculopathy. (OCT - optical coherence tomography, RE – right eye) - patient 3
Fig. 2b: OCT examination 7 weeks after exposure – adjustment of finding - patient 3

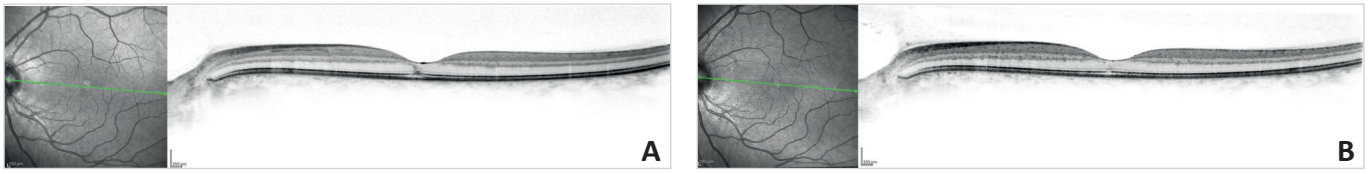

Fig. 3a: OCT finding in acute phase - patient 5
Fig. 3b: OCT finding after 7 weeks – Persistent change on level of RPE - patient 5

Table 2: BCVA and subjective evaluation after 7 weeks. (BCVA – best corrected visual acuity, RE – right eye, LE – left eye, RLE – both eyes).

TABLE 2					
PACIENT	VĚK	SUBJEKTIVNÍ POTÍŽE po 7 týdnech	LATERALITA POSTIŽENÍ	NKZO - PO 7 TÝDNECH (postižené oko)	SUBJEKTIVNÍ HODNOCENÍ STAVU po 7 týdnech
woman 1	16	persistent central scotoma	OS	6/6	improvement
woman 2	20	metamorphopsia minor	OD	6/6	improvement
woman 3	22	central scotoma	OD	6/6	improvement
woman 4	32	smaller central scotoma	OS	6/6	improvement
woman 5	37	bilaterally smaller central scotoma	ODS	6/9 ; 6/6	improvement

DISCUSSION

Mentions of deterioration of sight upon watching a solar eclipse or its reflection in water date back as far as Plato and Galenus [13]. The first doctor to describe a reduction of visual acuity by solar rays was the Swiss doctor Bonetus in the 17th century [19]. An ophthalmoscopic finding of a retina burnt by solar radiation was first described by Dufour in 1882 [14].

Damage to the outer layers of the retina is a characteristic symptom of solar maculopathy [19]. Most susceptible are the layer of the retinal pigment epithelium and the outer segments of the photoreceptors [3]. Cogenotti et al. [4] described 3 different theories of the mechanism of damage to the retina. The first, which is today the most widely accepted and recognised, is the theory of photochemical damage by light with shorter wavelengths, close to UV radiation. The second theory holds that an increase in temperature occurs in the RPE due to the influence of absorption of solar energy, causing damage to the surrounding tissue. The third theory refers to a combination of the previous factors, thus a combination of photochemical and thermal damage. Young people are affected by solar maculopathy more frequently than the older population, in particular due to the higher transparency of their optic media, primarily the lens [6]. The lens begins to protect the retina from UV light (300 – 400 nm) at around 20 years of age, and absorption progressively increases to a maximum at the age of approximately 30 years. Later the lens protects the retina also against short-wave visible blue light [19]. A further important factor which influences the severity of retinal damage is the length of exposure [7].

Looking directly at the sun is not recommended under any circumstances. When watching a solar eclipse it is necessary to use quality protective filters. Shirley recommends at least the same level of filter as is used in welding glasses [17]. Indirect methods are more suitable for watching, such as the projection method, obtaining a video recording and watching on a monitor, observatories etc. [12].

The first symptoms of solar maculopathy mostly develop between 1 and 4 hours after exposure [10]. The most frequent of these include central scotoma, reduced central visual acuity, metamorphopsia or erythropsia [12]. Paracentral scotoma is less common [14]. A proportion of patients may also be asymptomatic. Best corrected visual acuity fluctuates within a wide range from 6/6 to the level of counting fingers in front of the eye. Average visual acuity is most often 6/12 to 6/18 [18].

The diagnosis of solar maculopathy relies primarily upon careful anamnesis, ophthalmoscopic finding of a yellowish-white lesion in the centre of the foveola and paraclinical examination. At present a central role is played by optical coherence tomography. On today's Spectral Domain OCT instruments (SD - OCT) it is possible to identify hyporeflective areas in the outer retinal layers in the acute phase, primarily in the outer segments of the photoreceptors and the RPE, or a hyperreflective deposit of the neuroretina [19]. Suspicion of this diagnosis has been stated several times merely on the basis of a typical anamnesis and the ophthalmoscopic finding on the patient's fundus. Nevertheless, OCT diagnosis is highly valuable in illustrating the pathological changes of the photoreceptors and RPE, which may not always be perceptible ophthalmoscopically [19].

In afflicted individuals a spontaneous correction of central visual acuity usually takes place within a few weeks to months. However, even despite improving central visual acuity, patients may perceive central scotoma [19]. In our cohort we recorded an improvement of BCVA in four patients 7 weeks after exposure.

A retina which has been afflicted by solar maculopathy in the past is later more vulnerable also to relatively small stimuli. Kőhlerová and Tarbajovská [11] present a case study of a 13 year old girl who watched a solar eclipse in 1976. Immediately afterwards she had BCVA of 6/18 in both eyes with relative central scotoma. After 8 days her visual functions corrected themselves ad integrum. A year and a half later she

was dazzled by a small mirror used by her fellow school pupils. Although a number of her fellow pupils were similarly dazzled, a deterioration of BCVA was recorded only in this patient. However, this time the changes were permanent.

Jakúbková [8] described a cohort of 7 patients (11 eyes) after watching a partial solar eclipse on 30 June 1953. 5 women and 2 men were affected. In four cases both eyes were affected, in three cases only 1 eye, all of them the right eye. The patients were observed, and rest, dark glasses and dionine were recommended. One patient with severe bilateral affliction was additionally treated with subconjunctival application of cortisone (5 mg). In all 7 patients the course and improvement of visual functions was very favourable.

Preisová et al. [14] described a cohort of 15 patients (19 eyes) with solar retinopathy after watching the same solar eclipse in 1954. The patients were 8 women, 6 men and one child. In 11 patients only 1 eye was afflicted, in 4 patients the affliction was bilateral. In this study the authors observed permanent changes relatively often. Central scotoma persisted in 60% of the patients even at the follow-up examinations. Visual acuity also remained permanently reduced in 3 eyes.

An extensive cohort of patients was published by N. Rai et al. [15]. These authors examined a total of 319 patients in Nepal over the course of 20 months. Only 156 of those affected (56%) were aware that they had looked at the sun. Of these, 126 (40%) stated anamnestically watching the sun during the course of its eclipse, 33 (10%) were sun worshippers and 4 patients (1%) fell within both categories. The youngest patient was aged 11 years, the oldest 63 years. In more than 80% of cases baseline visual acuity was 6/12 or better.

N. Khatib et al. [10] described a series of case studies of 4 patients who suffered solar maculopathy after watching a solar eclipse in 2011. This concerned young patients within the age range of 14 to 29 years. In three cases the changes on the macula were reversible, in one case visual acuity remained unchanged.

H. Arda et al. [1] published a cohort of 6 young patients (8 eyes), including 3 children (6 eyes) within the age range of 12 – 14 years. Visual acuity at the first visit was within the range of 20/32 to 20/20. 2 months later it had improved to a level from 20/25 to 20/20.

S. C. Wong et al. [20] published a prospective study of 45 patients who had watched the same solar eclipse in 1999. The age range was relatively broad, from 15 to 82 years. The ratio of men to women was 21:24. 26 patients complained of bilateral affliction, 14 were affected unilaterally and 5 patients were asymptomatic. Of the 40 patients who stated complaints, 20 perceived deteriorated visual acuity and central or paracentral scotoma. The other 20 patients stated only a feeling of discomfort in the eyes. The severity of the symptoms and changes on the ocular fundus correlated to the duration for which the patients watched the solar eclipse. In the majority of the patients spontaneous improvement occurred. However, 4 patients remained symptomatic even after 7 months, and complete return of visual functions did not take place.

No causal treatment of solar maculopathy is known [9]. The majority of doctors only observe patients until a correction of visual functions takes place. Our patients were also only observed without therapy. However, cases have been described which responded positively to therapy with corticosteroids. For example, the authors Schatz and Mendelblatt [18] published a case study of a man with solar maculopathy accompanied by macular edema in both eyes. Baseline visual acuity was 20/40 bilaterally. The patient was treated with peroral doses of 15mg Prednisone 4x daily. Over the course of 9 days edema disappeared and there was an improvement of visual acuity to 20/25 in the right eye and 20/20 in the left eye.

In our cohort, during a seven-week observation period we recorded spontaneous improvement of BCVA in four unilaterally affected patients. Visual acuity in the dominant right eye did not improve in the bilaterally affected patient, who watched the solar eclipse through sunglasses. Subjective complaints persist in all the patients in the form of relative central scotoma or metamorphopsia. This type of persistent central scotoma has also been described previously in the literature. Preisová et al. [14] published similar results of persistent central blind spots in the visual field in 60% of patients also at subsequent examinations. The clinical course of injury to the retina due to the effect of solar radiation in the patients in our cohort corresponds to previously published studies dealing with this issue.

The prognosis is very often favourable in the case of solar maculopathy [8]. Over the course of a few weeks to months, visual functions in the majority of patients return to the level they were at before the injury [10]. However, in certain cases atrophy of the RPE of the macula or the formation of an outer lamellar macular hole may occur [12]. At the end of the seven-week observation period we recorded persistent minor changes in the layer of the RPE in 3 cases, whilst in the other cases there was complete regression of the deposit changes on SD - OCT.

CONCLUSION

Watching a solar eclipse without the corresponding protective aids may cause irreversible damage to the retina, with a reduction of central visual acuity to a varying degree. In our cohort, BCVA corrected itself after seven weeks in four patients with bilateral affliction, whilst in the last patient who was affected bilaterally reduced BCVA persists in the right eye, and in the left eye the patient perceives central scotoma of a smaller scope.

More emphatic nationwide education via the communications media concerning observation of the astronomical phenomenon of partial or full solar eclipse could bring about a reduction in the number of cases of solar maculopathy.

LITERATURE

1. **Arda, H., Oner, A., Mutlu, S. et al.:** Multifocal electroretinogram for assessing sun damage following the solar eclipse of 29 March 2006: multifocal electroretinography in solar maculopathy. Doc Ophthalmol, 114, 2007, 3: 159–162.
2. **Bechmann, M., Ehrt, O., Thiel, M.J. et al.:** Optical coherence tomography findings in early solar retinopathy. Br J Ophthalmol, 84; 2000, 5: 547–548.
3. **Chen, K.C., Jung, J.J., Aizman, A.:** Solar Retinopathy: Etiology, Diagnosis, and Treatment. Retin Physician, 10; 2013: 46–50.
4. **Codenotti, M., Patteli, F., Brancato, R.:** OCT findings in patients with retinopathy after watching solar eclipse. Ophthalmologica, 216; 2002, 6: 463–466.
5. **Comander, J., Gardiner, M., Loewenstein, J.:** High-Resolution Optical Coherence Tomography Findings in Solar Maculopathy and the Differential Diagnosis of Outer Retinal Holes. Am J Ophthalmol, 152; 2011, 3: 413–419.
6. **Dhir, S.P., Gupta, A., Jain, I.S.:** Eclipse retinopathy. Br J Ophthalmol, 65; 1981, 1: 42–45.
7. **Hossein, M., Bonyadi, M., Soheilian, R. et al.:** Spectral-Domain Optical Coherence Tomography Features of Mild and Severe Acute Solar Retinopathy. Ophthalmic Surg Lasers Imaging, 42; 2011: 84–86.
8. **Jakúbková, M.:** Změny sítnice po pozorování zatmění slunce. Čs Oftal, 11; 1955, 3: 150–156.
9. **Kanski, J.J., Bowling B.:** Clinical Ophthalmology: a systematic approach, 7th ed. Edinburgh, Elsevier Saunders, 2011, 909 s.
10. **Khatib, N., Knyazer, B., Lifshitz, T. et al.:** Acute eclipse retinopathy: A small case series. J Optom, 7; 2014, 4: 225–228.
11. **Köhlerová, Ž., Tarbajovská, E.:** Solárna retinitida. Čs Oftal, 37; 1981, 1: 44–46.
12. **Kuchynka, P.:** Oční lékařství, Praha, Grada, 2007, 768 s.
13. Moráň, M.: Poškození sítnice slunečním zářením. Vojen Zdrav Listy, 25; 1956, 5: 223–227.
14. **Preisová, J., Dluhošová, O., Mrkosová, Z.:** Poškození sítnice po pozorování částečného zatmění slunce 30. VI. 1954 v Brněnském kraji. Čs Oftal, 11; 1955, 6: 442–444.
15. **Rai, N., Thuladar, L., Brandt, F. et al.:** Solar retinopathy. A study from Nepal and from Germany. Doc Ophthalmol, 95; 1998, 2: 99–108.
16. **Sherman, J., Slotnick, S.:** Letter. J Am Optom Assoc, 83; 2012, 1: 6.
17. **Shirley, S.:** Solar retinitis. Can Med Assoc J, 89; 1963, 3:134–135.
18. **Schatz, H., Mendelblatt, F.:** Solar retinopathy from sun-gazing under the influence of LSD. Br J Ophthalmol, 57; 1973, 4: 270–273.
19. **Suhr, C.L., Buffano, R.M., Sellers, A.:** The use of optical coherence tomography to aid in diagnosing solar maculopathy. Optometry, 82; 2011, 8: 481–484.
20. **Wong, S.C., Eke, T., Ziakas, N.G.:** Eclipse burns: a prospective study of solar retinopathy following the 1999 solar eclipse. Lancet, 357; 2001: 199–200.