CLINICAL STUDY

Eclipse retinopathy

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Abstract

Purpose **Solar retinopathy is a well-recognised clinical entity of macular damage caused by viewing the sun, induced by a photochemical process. The term 'eclipse retinopathy' is frequently employed when the condition is sustained as a result of viewing a solar eclipse. Considerable public excitement had been raised in anticipation of the full solar eclipse on 11 August 1999. Whilst experience has shown that visual morbidity is likely to be temporary, current evidence is anecdotal and restricted to isolated case reports and series. This study was conducted to establish the true visual morbidity associated with a solar eclipse, and whether it was temporary or permanent.**

Methods **A 3 month active case ascertainment study was carried out from July to September 1999 to record cases presenting to ophthalmologists with visual symptoms arising from solar viewing. Further information about the cases was sought using a short questionnaire. A follow-up questionnaire requesting outcome data at 6 months was also employed.**

Results **There were 70 reported cases of visual loss. The average age was 29.5 ± 12.9 years. Half the cases presented to an ophthalmologist within 2 days of the eclipse. An abnormal macular appearance was reported in 84% of patients at presentation. There have been no reported cases of continued visual loss or symptoms at 6 months.**

Conclusions **This is the largest nationwide study of the visual effects of a solar eclipse ever undertaken. There were no recorded cases of permanent visual loss, which corroborates the previous evidence that visual morbidity is likely to be temporary. It would appear probable that public health education was most effective in reducing visual morbidity and hence keeping the consequent burden on the NHS to a minimum.**

Key words Eclipse blindness, Eclipse retinopathy, Macula, Photoretinitis, Retina, Solar eclipse, Solar retinopathy

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It has been known since ancient times that gazing into the sun could lead to visual disturbance. Socrates cautioned against viewing a solar eclipse directly:

> People may injure their bodily eyes
> By observing and gazing on the sun during an eclipse
> Unless they take the precautions
> Of only looking at the image reflected
> In the water or some similar medium
>
> *Socrates (470–399 BC), quoted by Plato in* Phaedo

Galileo was said to have injured his eyes whilst looking at the sun through his newly invented refracting telescope, as did the father of photocoagulation, Meyer-Schwickerath, when experimenting with the production of radiant energy.

In more recent times, numerous accounts of solar retinopathy have appeared in the literature. Most cases have involved individuals who witnessed a solar eclipse with inadequate protection.[1,2] Other cases have been reported in individuals who have gazed at the sun directly, such as sunbathers,[3] military gunners,[4] patients with mental illness[5] and hallucinogenic drug users.[6] Religious rituals and misconceptions regarding the benefits of sun gazing, such as Bates' method[7] for the treatment of myopia, are responsible for other cases.

Considerable public excitement had been raised in anticipation of the full solar eclipse on 11 August 1999. However, there was also mounting public and professional concern about potential blindness arising from unguarded viewing of the event. Whilst experience has shown that visual morbidity is likely to be temporary, current evidence is anecdotal and restricted to isolated case reports and series. Therefore this study was conducted to establish the true visual morbidity associated with a solar eclipse, and whether it was temporary or permanent. This is the largest investigation of its kind ever conducted into this matter.

Materials and methods

A 3 month active case ascertainment study was carried out from July to September 1999 to record cases presenting to ophthalmologists with visual symptoms arising from solar viewing. This was conducted with the assistance of the British Ophthalmological Surveillance Unit.

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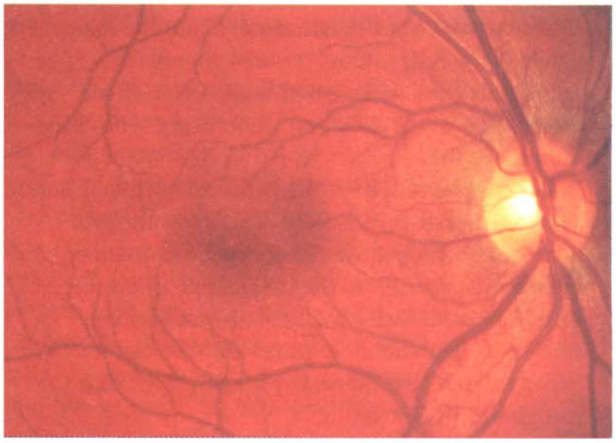

Fig. 1. *Fundus photograph of a 33-year-old woman who viewed the sun for approximately 6 s with no protection. Amsler testing at presentation showed a central scotoma. A yellow cystic lesion can be seen at the macula.*

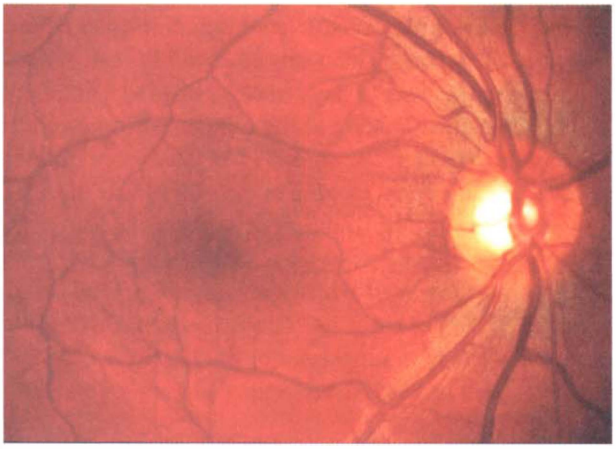

Fig. 2. *Fundus photograph of an 18-year-old man who viewed the sun for approximately 1 min with no protection. Amsler testing revealed a central scotoma. A yellow lesion can be seen at the macula.*

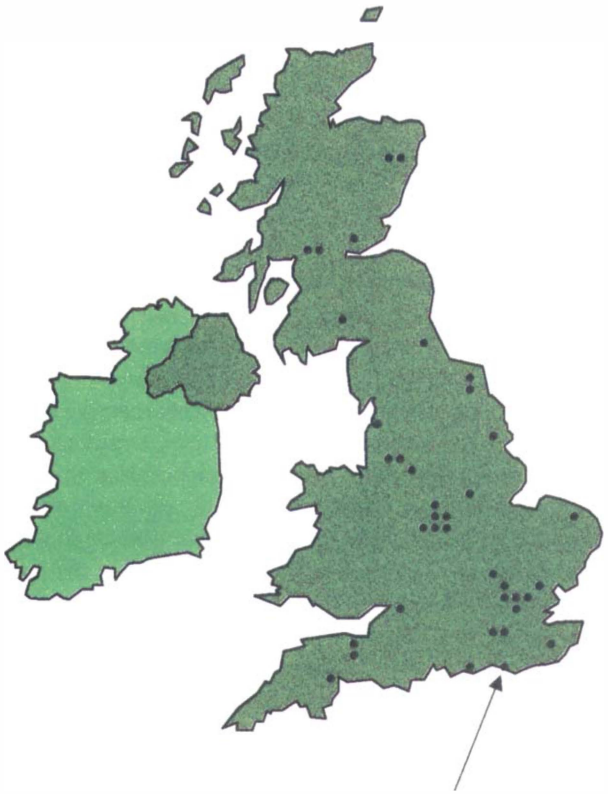

Fig. 3. *Case location at the time of the solar eclipse. Thirteen cases were reported in Brighton (arrow). Seven cases were abroad at the time and 13 in unknown locations.*

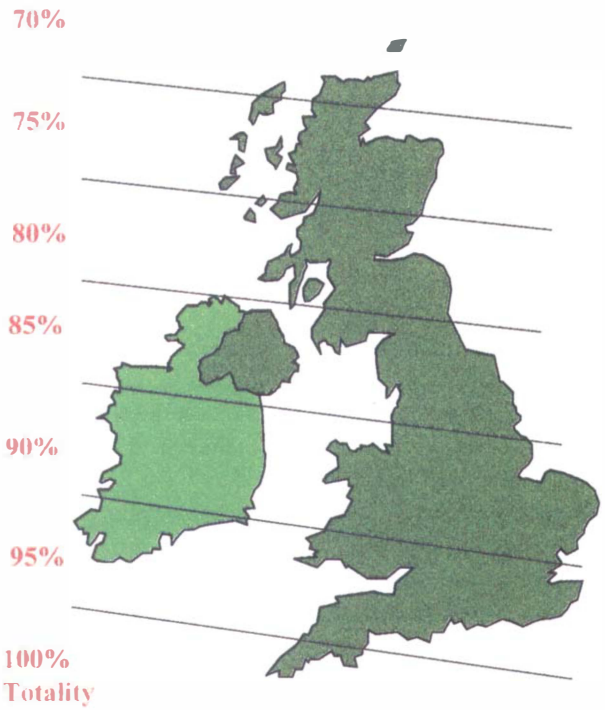

Fig. 4. *Percentage totality of the solar eclipse over the UK.*

Case definition

A case was defined as any person with newly acquired loss of vision of any degree, directly resulting from a viewing of the sun.

Further information about the cases was sought using a short questionnaire. All the information sought was routinely available from medical records. The patients were not contacted directly. A follow-up questionnaire requesting outcome data at 6 months was also sent to the principal reporting ophthalmologist requesting further details on the patient's visual acuity and fields.

The objectives of the study were: (i) to establish the number of patients presenting to ophthalmologists with visual loss arising as a consequence of eclipse viewing; (ii) to elucidate the relationship, if any, between visual loss and the percentage of totality of the solar eclipse experienced; and (iii) to determine the outcome in these cases.

Results

A background rate of zero cases was established before the August 1999 solar eclipse.

During the study period there were 70 reported cases of visual loss (38 males, 32 females). This represents a male:female ratio of 1.2:1.0. Their ages ranged from 9 to 71 years old, with an average age of 29.5 ± 12.9 years.

Half the cases presented to an ophthalmologist within 2 days of the eclipse. The mean interval between eclipse and presentation was 16 days (range 0 days to 5 months).

The time spent looking at the eclipse was reported to be seconds (less than 1 min) in 39% of cases. In a quarter of cases the time spent looking at the eclipse was minutes (range 1–45 min). The duration of exposure in the remaining percentage of cases was unspecified.

The protection used whilst viewing the eclipse was variable: (i) 56% of cases used no protection; (ii) 30% used filters, such as sunglasses or photographic negatives; and (iii) 14% used 'eclipse glasses' or welder's masks.

An abnormal macular appearance was reported in 84% of patients at presentation. Two typical examples of the observed pathology can be seen in Figs. 1 and 2.

There have been no reported cases of continued visual loss or symptoms at 6 months.

Discussion

Patients with classical solar retinopathy present soon after exposure with a history of reduced visual acuity, a central scotoma, chromatopsia, photophobia and metamorphopsia.[8–10] Most cases are bilateral but asymmetric, with a preponderance of the right eye being more affected than the left, presumably due to ocular dominance.[2,8,11]

The fundus examination depends on the severity of the photic damage. Examination of the macula within the first 24–48 h after solar exposure may yield little information. A subtle alteration in macular pigmentation, with or without minimal oedema, is often the only evidence of previous insult. Within 7 days, there is typically loss of the foveal reflex and the appearance of a small yellowish-white spot, presumed to be exudative material, at or near the foveola. Over the next 2–4 weeks, this yellow spot may gradually fade completely or remain as a smaller white area of apparent retinal pigment epithelium (RPE) hypopigmentation. Concomitant with these changes, the fovea becomes increasingly erythematous, and the lesion assumes the appearance of a small reddish foveal cyst or lamellar hole surrounded by an area of pale grey granular pigmentation.[1,6,12,13] Ultimately, the foveal erythema subsides, leaving only an irregularly pigmented macula and a small area of foveal hypopigmentation.

Fluorescein angiography often reveals little or no abnormality, but in the acute stages a small focal area of leakage may be present.[14] A few severe cases have shown a minor degree of window defect secondary to atrophic changes in the RPE.[15,16]

Considering the large number of people who viewed the eclipse it may be somewhat surprising that only 70 cases of visual loss were reported, especially since the population of the UK is approximately 55 million. We offer the following reasons as a possible explanation:

1. Effective public health education about the dangers of viewing the eclipse directly, which either led to appropriate measures being taken for indirect viewing, or to suitable protection being worn for direct viewing.
2. Public awareness about the expected transient nature of the visual disturbances that may result from unprotected eclipse watching, with a consequent low rate of presentation to the medical profession.
3. Primary health care professionals not seeking specialist ophthalmological review due to the expected transient morbidity and the lack of a recognised treatment.
4. It may also be possible that not all the cases that were seen by ophthalmologists were reported to the British Ophthalmological Surveillance Unit.

Although several therapeutic agents have been tried, the medical treatment of solar retinopathy has primarily involved the use of steroids.[1,6,12,17] Despite isolated claims of success, adequately controlled clinical trials have yet to be conducted, although it may well be difficult to conduct such trials. Obviously, the best available treatment is prevention.

It can be seen from Figs. 3 and 4 that as the percentage of totality increased from the North to the South of the UK, there was also an increasing number of cases reported. The peak incidence appears to have been in the 95% totality zone. It may seem somewhat surprising that so few cases were reported in South-West England since they experienced 100% totality. One likely reason for this is that they also experienced very cloudy conditions.

Moreover, there is a common misconception that a solar eclipse is only dangerous to vision when viewed in the path of totality. In fact, the only time it is safe to view a solar eclipse, without protective devices, is in the path of totality during the total phase. Nevertheless, the total phase ends very suddenly, with the 'Diamond Ring' effect when the first segment of the photosphere re-appears. Immediately following this the hazards return.

The finding that the number of cases peaked in the 95% coverage area may be partly accounted for by the mistaken belief that with so much of the sun covered, it would be safe to look without protection. In addition, the avoidance reflex would not have been triggered by the brightness of the remaining crescent of sun, thus facilitating the injury. Thus it may be the case that people would have been staring more closely at a near-total eclipse and hence would incur more injury.

The lack of use of protection to view the eclipse resulted in no significant difference in the percentage of cases with macular pathology, nor in prognosis, compared with those who did take precautions. A possible explanation for this may be that the protection that was used by the cases was by definition inadequate or used incorrectly.

A number of commonly used 'protective' devices have been proven to be unsatisfactory for the direct observation of a solar eclipse.[18–20] These include sunglasses,. smoked glass, welder's goggles (less than

grade 14),[18] X-ray film, photographic negatives and a camera view finder. Paradoxically, many of these makeshift devices may actually augment the risk of incurring retinal injury by reducing the sun's glare and allowing for longer viewing.

The average age of the cases was 29.5 years. Only 3% of the cases (2 cases) were reported to have a refractive error. The greater incidence of eclipse retinopathy amongst younger patients with clear media and insignificant refractive errors suggests an increased capacity for sharp focusing of the sun's rays upon the retina, thereby leading to an increased risk of macular phototoxicity.[21–23] In addition, the relatively clearer media would permit greater transmission of radiant energy. Furthermore the curiosity level of young people may also be a factor leading to increased exposure during a solar eclipse.

A clear limitation of the study was that it was not possible to take into consideration the pre-eclipse visual acuity level of cases, thereby making it impossible to quantify the visual loss.

Half the cases presented to an ophthalmologist within 2 days of the eclipse. The mean interval between eclipse and presentation was 16 days. It is somewhat surprising that there were cases that presented more than 2–3 days after the eclipse. Generally, those who sustain an eclipse burn seek help within a day or two after the event. This is because the onset of symptoms is approximately 12 hours after the trauma as a rule. One possible reason for late presentation may have been the public awareness of the expectation that symptoms would be transient, with cases only presenting when the visual symptoms had failed to settle. Alternatively late presentation may be partly due to patients only lately noticing pre-existing pathology, with an increased awareness of visual symptoms due to the public health campaign on the potential visual dangers of the solar eclipse.

It would appear that solar retinopathy can be divided into the following two groups: (i) True retinal burns which arise as a result of magnifying the sun's image by viewing it through gathering optics, such as the telescope or binoculars. The prognosis for such solar burns is very poor. (ii) Photoretinitis, which is a photochemical insult to the retina, emanating from blue light and the few short-wavelength UV photons that reach the retina. The prognosis is generally excellent.

In this study, none of the cases used gathering optics and all received their insults as a result of photoretinitis. There were no recorded cases of permanent visual loss. This corrobates the previous evidence that visual morbidity is likely to be temporary, except in patients with mental illness or hallucinogenic drug users. The previous evidence was in the main anecdotal and restricted to isolated case reports and series.

This is the largest nationwide study of the visual effects of a solar eclipse ever undertaken. It would therefore appear probable that in this instance public health education was most effective in reducing visual morbidity and hence keeping the consequent burden on the NHS to a minimum.

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