light only and was subsequently enucleated for continued irritation, and one whose vision had fallen from poor projection to nil. The remaining two showed some increase in the vitreous haemorrhage, although diathermy barrage had been used at operation.

Summary

A description of 29 cases of intra-ocular foreign bodies mostly from Japanese grenades in the Assam-Burma Front is given.

The low-magnetic properties of the fragments necessitated posterior route extraction in most cases.

Ring X-ray localisation proved very accurate and the Haab test was of little value and often misleading.

The main causes of visual defect were vitreous haemorrhage and cataract.

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SOLAR RETINITIS*

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IN January, 1943, C. A. Pittar reported a rather unusual case of "hole in the macula" following indirect "sun gazing." The case assumed military as well as medico-legal importance for the pertinent data in the case report indicate that complete loss of vision was "in line of duty." The history obtained from the patient one and one half years after the acquisition revealed the fact that enemy planes had a habit of flying out of the sun, and being in charge of an anti-aircraft gun he had upon several occasions looked into the sun. He could not clearly recall one specific instance when he had gazed into the sun. The patient's record revealed that two years earlier he had had perfectly normal vision in each eye. Another record indicated that at the time of examination for a cinder in his right eye the ophthalmologist had noted "clouding of the macula along with pigmentation and

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haziness." There was at this time almost complete blurring of vision for three weeks' duration and a history of "sun exposure" was recalled.

In reconstructing the picture the following facts seem to stand out :

(a) The sailor had had 20/20 vision in each eye.

(b) Some time after watching planes fly out of the sun, a central scotoma developed with loss of vision for a period of three weeks. At this same time a cinder was present in the patient's eye.

(c) Fundus examination showed a picture typical of "solar retinitis," but it was mis-diagnosed and explained as corneal involvement.

(d) One and a half years later a typical macular hole was found in the right eye with vision of 2/60.

The author quotes Duke-Elder and states that no other single reference "of typical hole in the macula due to exposure to sunlight" has been reported. He analyses the three cases cited by Duke-Elder of other authors, *viz.*, Würdemann, Harmon and McDonald and Rauh, showing that these cases are not photo-traumatic holes in the macula since they were caused by other elements. Würdemann's case report was not one of eclipse blindness but hole production in the macula in a patient who looked into a welding flash for two to four minutes. This patient was a myopic female (-6.0 dioptres). A typical "Berlin opacity" of the macula was reported along with multiple radial macular haemorrhages. Later the macula developed a greenish cast with a whitish centre. The final appearance was a typical hole in the macula. The author placed emphasis upon the fact that only a few seconds' exposure will destroy the delicate system of nerve elements in the macula. The author also believes the process in sun gazing, electricity, lighting, etc., is very similar. The appearance of this lesion is not unlike that described in our first case, *viz.*, the "yogi sun gazer."

In Harmon and McDonald's case, no true hole in the macula was observed, rather a retinal detachment developed which was subsequently followed by striation and scarring in the macula but not hole formation.

In October, 1943, I had the extreme good fortune to examine a patient who apparently fitted into the pattern described by C. A. Pittar. This patient was a 24-year-old Mexican who stated that he directed his gaze into the sun and maintained fixation constantly for a period of fifteen to twenty-five minutes. He also stated that at first the sun appeared as a complete blur with no visible structure but after a short period its shape could gradually be made out.

For three days following this act, the patient noticed a large round black spot in front of each eye. In time this spot became smaller in diameter and after one week the scotomata continued to maintain a constant size. At present the spots are round upon direct visual localisation.

The patient's vision was 20/100 in each eye and could not be further corrected. The initial fundus examination, which was made about six weeks after this episode, showed each macula to have a peculiar greenish colour with a pigment halo following just around the foveal reflex. Anterior to the foveal depression in each eye was a small whitish grey fluffy area. This looked very much like a "powder puff" being somewhat transparent and allowing a slightly translucent glow when viewed by retro-illumination (method of Friedenwald). This picture was more or less bilaterally symmetrical. When re-examined ten days later the "puffs" had disappeared and each macula had taken on an increasingly darkened area. Five weeks later it was noted that a definite hole had appeared in each macula. These holes were rather small yet cleanly punched out and girdled by a pigment halo. In another two weeks each hole appeared oval horizontally with a pronounced pigmentary ring. There was little change in this picture in the next six weeks.

While obtaining the patient's history I had casually mentioned to one of the medical men that "sun gazing" was frequently practised in India as a religious ritual. I asked the patient if he had ever practised yogyism. This he denied. Sometime later I read the following in Elliot's Tropical Ophthalmology :

"Sun-blindness, with macular degeneration, is not uncommonly met with, and the ophthalmoscopic picture is quite characteristic. The macula forms a crater of deep crimson colour, $\frac{1}{8}$ disc diameter in width, the edges of which are sharply cut and irregular in shape; it is surrounded by a soft cloud of pigment.

"In this connection, it is interesting to note that it is part of the Brahmin ritual to look at the sun whilst reciting a particular 'mantram' during the mid-day prayer. The practice is to fold the fingers in a peculiar manner, and look at the sun through the interspaces. The orthodox fashion of dodging the fingers leaves an aperture of about an inch square, but it seems that all Brahmins are not equally particular as to the manner of folding the hands; indeed, some of them do not even go outside the house to perform the rite, but are content to take the presence of the sun for granted, and merely to address the light. The mantram itself only takes three or four seconds to recite but one may imagine that the tropical sun, if looked at directly, is capable of doing damage, even in this short space of time. In some places it appears to be

the custom to look at the rising sun directly, without the intervention of the fingers, and in such a case the time may be extended to four or five minutes. It is remarkable that this disease is by no means confined to Brahmins; indeed those who are not Brahmins have furnished the majority of the patients. The probable explanation is that this practice, having a religious sanction, is followed by men of other castes, and that these imitators are inclined to carry it to excess; it is sometimes considered to be "lucky" and to confer supernatural powers. This idea most likely originates in the extensive use of self-hypnotism by "yogis," who, for this purpose, are in the habit of fixing a sustained gaze on some bright object, or of using their eyes in some manner which entails a fatigue of the ocular muscles. Thus a common yogi habit is to gaze at the tip of the nose or at the eyebrows, the power of sustained over-convergence, which they thus acquire, is, in some cases, astonishing. Sun-gazing in the morning and evening appears to be one of the methods of self-hypnotism. Amongst the less zealous worshippers the disease is often monocular, as some, at least, of them appear to have a doubt as to the wisdom of tampering with such things, and, tempering their zeal with discretion, risk the sight of one eye only. On the whole it is extraordinary that sun-blindness is not more common than it is."

In October, 1943, L. Pavia and Lachman described two cases of very small holes in the maculae due to photo-traumatism. These authors describe three types of "solar" injury and they show three fundus photographs with typical macular holes. One case was unilateral, the second bilateral. In each case the history was typical, *i.e.*, an eclipse was observed with no apparent protective measures: There was sudden loss of vision with gradual restoration after a period of days—but not complete restoration. The patients were not examined until several years later, at which time typical macular holes were found. The unilateral case was complicated by an endocrine dysfunction.

Pavia and Lachman review the literature and state that most authors stress the oedema, clouding and pigmentation which occur in the macula with little emphasis being placed upon the final macular picture. Animal experimentation was quoted to show the nature of the pathological lesion in the macula concerning which changes some controversial opinions had arisen. However, in the last analysis the anatomical difference of man and animal, particularly in the macular region, was stressed.

The human experiments of Maggiore did not enlighten the picture very much either, since this author used primarily an artificial light source at a very near distance. In conclusion,

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Pavia and Lachman emphasise the patient's refraction; the distance of the source of light; the intensity of the light and the interval of time before examination to explain the occurrence of the small macular holes.

In the past year I have had occasion to observe a great many cases, during routine examination, which showed these small, easily overlooked macular holes. When discovered I have checked back upon the patient's history, trying not to ask leading questions and in all cases I have elicited a history of "sun-gazing" or a related act. In most instances these patients recall with facility all the events accompanying the act of sun-gazing. A prepared table includes many of the methods and some of the protective procedures followed by these patients.

Review of these cases seems to indicate that many patients recall gazing into an eclipse through self smoked glasses. In many cases one eye was covered for protection. The macular holes were of a very small variety. In some instances the method of development was rather peculiar, such as gazing into a stream of water, a water pail or looking through a self-made stenopaic slit. The time interval varied from five minutes to an hour and a half. One patient believed that the eye became strong through gazing into the sun. He had come to believe through folk lore or some local teaching, that to become "eagle eyed" one must gaze into the sun even as the eagle does. In other cases the patient stated that he along with other boys gazed into the sun for several minutes and that many of those in this same group suffered from similar ocular troubles years later. One patient (No. 12) not only looked at the sun through smoked glasses for several minutes but also used to study the sun through a telescope. His cousin also had an eye complaint very much like his and had sought ocular aid without benefit.

In 1944, H. E. Smith reviewed 150 cases in military personnel stationed in a tropical country. These were men whose visual acuity had been previously recorded by this same observer. They were subsequently exposed to tropical sun, working out doors, etc. After a period of six months it was noted that these men had fallen in vision from 20/20 to 20/30 and that this vision could not be improved through refraction. The author noted that in each case the fundus lesion was more or less typical regarding macular disturbance. He described three fundus patterns which were very constant. Smith pointed out that these men worked at all times in the bright sunlight—being unprotected from glare and for the most part not used to this strength of sunlight. The author did not discuss the pigmentation of these men, nor the prophylactic measures taken against the strong sun nor the subsequent and

final course of the macular lesion (probably as yet too early). However, these case reports seem to bridge the gap between the many descriptions of the acute oedema following eclipse blindness and the ultimate small macular holes found many years later. Since the condition is far from rare and since the problem is largely one of prevention, it is urged that this subject be placed before many who are unaware of the dangers of "sun-gazing." That the danger is not recognised by ophthalmologist as well as by the unsuspecting sun worshipper may be readily realised when one quotes directly from Troncoso's text book upon Internal Diseases of the Eye and Atlas of Ophthalmoscopy (page 382).

"The use of smoked glasses during sun eclipses will prevent injury to the retina."

Case 23 is an excellent example of the medico-legal importance of this condition. This man had vision of 20/20 in each eye at the induction examination. One and a half years ago while he was stationed in Alaska he gazed at an eclipse for five minutes through a small opening made by his own hand. He used one eye and then the other. There were no immediate after effects. At present his vision is 20/70 in his right and 20/50 in his left. There are holes in each macula to correspond with the vision of each eye. The causal relationship seems quite clear in this case. The problem of education along preventive medical lines seems almost as glaring.

Report of cases

CASE 1.—The patient is the above-mentioned Mexican, aged 24 years, who gazed constantly at the sun for a period of 15 to 20 minutes and developed the several changes which we followed and described in an earlier paragraph.

CASE 2.—This is the case of a soldier, aged 26 years, whose vision was 20/100 in the right eye and 20/20 in the left eye, no improvement being obtained upon refraction. In the right macula a very small "kidney bean" hole was present with the long axis lying horizontal, and a lighter halo surrounding the small hole. There was some increased pigmentation beyond this point. The nerve head and fundus otherwise was normal, as was the fundus of the left eye. The patient recalled that thirteen years earlier he had observed an eclipse at which time he had smoked a piece of glass and had gazed intently at the sun while keeping his left eye closed. When he returned for a second examination he was able to recall that his right eye had remained blurred for a few days following the "sun gazing." At first quite a definite golden ball was present, but this gradually disappeared, although not completely. He had done nothing about this condition and had never connected his poor central vision in his right eye with this episode of sun gazing. He knows that although he is right handed, he has learned to use his left eye as his dominant one.

CASE 3.—This patient, J.E.J., aged 20 years, stated that when he was six or seven years old he had watched the structure of the sun through reflection into a bucket of water as part of a religious ritual. He does not remember how long he gazed into the bucket of water nor how long his eyes were troubled as a result of this procedure, but he does remember that he had a good deal of discomfort following this episode. He had had his vision checked at school upon many occasions, but had never been given any glasses. The right fundus showed a

tiny hole in the foveal area, quite dark, undermined and horizontally elongated. The hole in the left macula was slightly smaller, also horizontally elongated with a surrounding pigment halo and two small dots of yellowish colour at its centre. (Case 3.) The retinæ otherwise were negative. Central fields showed two small absolute scotomata corresponding in size and shape to the original lesion.

CASE 4.—This soldier, aged 24 years, recalls watching an eclipse without any protective mechanism other than self-smoked glasses for a period close to one hour when he was 17 years of age. He well remembers the after-effects, for he was unable to read print for three or four days because of a constant dazzle in front

of his eyes during this period. This effect gradually disappeared at the end of one week, although his right eye thereafter seemed to have a permanent blank area when looking straight ahead. He did not have this condition investigated at the onset, although he tried later to secure glasses without benefit. Examination of the fundi showed a small macular hole in each eye very similar to the "hole" seen in Case 3. Here also were two small round yellowish spots at the base of the hole which ran in a horizontal plane and had a small yellowish lighter halo about the very dark red punched-out centre. The right macular hole was somewhat larger and more oval than the left hole. Vision in this patient's right eye was 20/400 and in the left eye was 20/50, uncorrectable.

CASE 5.—This male, aged 25 years, had vision of 20/100 in the right eye and 20/20 in his left eye, not improved with glasses. On checking the patient's history he was able to recall watching a sun eclipse through self-smoked glasses for a period well over an hour, during which time he remembered keeping his left eye closed. He doesn't remember the exact effect this had upon his eyes other than

that he was very uncomfortable for several days thereafter. He had completely forgotten this experience, and in no way did he connect it with his poor vision in the right eye. Examination of the fundus of the left eye was not abnormal; that of the right showed a peculiarly shaped spindle-like hole with a dark symmetrical ring around the spindle. Increased pigmentation could be seen around this area. The fundus otherwise was negative. A central defect corresponding to this hole in shape and position was mapped out upon the tangent screen.

CASE 6.—T.J., a male, aged 36 years, had vision of 20/70 in his right eye correctible to 20/20 and 20/100 in his left eye—uncorrectable. Twenty years earlier he had watched an eclipse for a period of one hour and at that time

distinctly remembers closing his right eye. He believes he gazed at the sun for a period of one-half hour and that for several days thereafter his vision was quite blurred, remaining that way. The right fundus showed no abnormality. The left fundus presented a characteristic macular lesion consisting of a minute macular retort-like lesion running horizontally and being surrounded by a definitely lighter halo outside which was an area of increased pigmentation extending for a distance equivalent to one disc in diameter.

CASE 7.—Although this male, aged 22 years, had vision of 20/20 in each eye, yet a very tiny hole was discovered in his right eye. He recalls gazing into an eclipse when he was about 12 years old. He believes his left eye was covered at the time, but doesn't recall that he used any protective method. At most he believes his gaze was directed toward the sun for a period of three minutes. He was not aware of any after images or immediate visual disturbance. Examination of his right fundus disclosed a very small dark red macular lesion, more or less oval in shape with two small yellow dots within its centre. There was a slight suggestion of a halo around the hole and a small zone of increased pigmentation. The left fundus was normal.

CASE 8.—This adult, aged 26 years, had vision of 20/40 in each eye which could not be improved. Examination of his fundi showed bilateral hole formation, the right eye being multiple (Fig. 5, Case 8), the left eye being single, obliquely oval

and heavily pigmented. Fig. 5 shows the right macular lesion consisting of three very tiny separate holes, one being crescentic, one being circular and the third being very small and shaped like a figure 8. The retina between the holes was very shiny and almost silvery. The central lesions were surrounded by a circle of small pin point dots, with the area showing increased pigmentation. The crescentic lesion appeared deepest; the circular lesion had a yellowish centre. No history of sun gazing or eclipse viewing could be obtained from this patient who insisted that he had developed his eye trouble while upon desert manoeuvres during the past six months during which time he had been troubled by the reflection of the sun from the desert sand.

CASE 9.—This patient, aged 25 years, gave a definite history of gazing into the sun at the age of eleven for a period of fifteen minutes, his left eye being closed and his right eye viewing the sun through a smoked glass. There was a definite visual aftermath, although the patient doesn't remember any of the details. At present vision is 20/40 in his right eye and 20/30 in his left eye in which eye vision can be corrected to 20/20. The right macula shows a very small "banana" shaped hole with two polar yellow dots and a discrete circum-macular halo. The central field showed a very minute defect corresponding to this macular lesion.

CASE 10.—The patient stated that vision in his right eye was poor as long as he can remember. Vision in this eye is 8/200, in the left eye 20/20. Upon further questioning he admitted that when he was seven years of age he had observed an eclipse without protecting his eyes. He believes that he watched the phenomenon for at least five minutes. However, he cannot describe any subsequent ocular symptoms. The left fundus appeared to be perfectly normal. The right fundus showed a small hour glass, punched out, dark macular hole with two small round yellowish dots. There was no halo around this lesion although there was an area of increased pigmentation extending about the macular lesion as large as one disc's diameter.

CASE 11.—U.A., aged 26 years, had vision of 20/30 in each eye. About six years ago he had carefully studied "sun spots" by gazing into a stream steadily for several minutes. His vision following this procedure has not been as good as it was prior to this experiment. He had tried to secure glasses to correct this visual defect on several occasions but was never fitted satisfactorily. Case 11 shows a typical macular lesion shaped like a spindle running in the vertical direction with a small whitish-yellow dot in the centre. The lesion is typically punched out and is surrounded by a girdle of very small dark dots along with an included area of increased pigmentation. The left eye is very similar to this right eye. There is no other fundus pathology. The central fields show typical central scotomata.

CASE 12.—This patient, aged 21 years, had vision of 20/200 in his right eye and 20/30 in his left eye. When he was eighteen years of age he had watched an eclipse both through smoked glasses and through a telescope in an endeavour to study the phenomenon. In watching the sun a smoked glass was used over his eye as well as over the telescope. The history of visual disturbance following this procedure was very precise; in fact, the patient knows that others who viewed the eclipse through this telescope also have developed some form of "eye trouble." The right fundus shows a very definite hole made up of two components as shown in the illustration Case 12. This hole is not dark red, but has a definite punched-out appearance along with an area of increased pigmentation. The left fundus is normal.

CASE 13.—This soldier, aged 29 years, recalls gazing at an eclipse when 21 years of age, using both eyes with no manner of protection other than carbon deposition upon a broken piece of glass. Again the exact time interval is not known, but it is the patient's belief that possibly a whole hour was consumed in this nefarious procedure. Visual impairment was immediate and definite, and at present is 20/30 in the right eye and 20/70 in the left eye, no further improvement being obtainable. There is only a slight hyperopic correction in each eye. Although there is a marked visual difference in each eye, the lesions in each macula are fairly similar: The figure, Case 13, illustrates the appearance of the lesion in the left eye which is very similar to the lesion depicted in Case 7.

CASE 14.—This patient observed an eclipse of the sun by gazing into a stream

when he was 19 years old. This incident occurred nine years ago at which time no smoked glass or other device was used. Both eyes were kept open during the phenomenon, which lasted some five minutes, and was completely observed by the patient. This was followed by bilateral central scotomata which persisted for several days and gradually but incompletely disappeared. No medical aid was sought, for vision returned to its present status of 20/30 right, and 20/70 left, no further improvement being secured through attempted refraction. The hole in the left eye is illustrated in Fig., Case 14. There is a vertical, rather minute, punched-out hole shaped like an italic letter (*o*), surrounded by a very definite lighter halo, and an area of markedly increased pigmentation. A very definite central scotoma is present in each eye.

CASE 15.—This patient, C.E., aged 33 years, recalls gazing at an eclipse 12 years ago through a self-smoked glass while keeping his left eye closed. After five minutes he discontinued the process. He noticed that a blur persisted in front of his right eye which did not vanish, although it became much less intense after several days. He was particularly annoyed while sighting through a rifle, noting that he could sight much better slightly off centre. These symptoms have persisted ever since. Examination of the right macula showed an inverted heart shaped lesion with a halo around it, and area of increased pigmentation around

the foveolar area. There was a small central scotoma in this eye. The fundus of the left eye was quite normal.

CASE 16.—J.P., aged 15 years, had gazed upon a sun eclipse for fully twenty minutes through his right eye with no form of protective glass. There was immediate loss of vision which persisted for several days, gradually clearing somewhat, but remaining approximately 20/400, although the patient claimed he could see nothing more than large objects with his right eye. There were no signs or symptoms referable to his left eye. Examination of the right fundus

showed a moderately large, dark hole shaped like a hammer head and running vertically. It, too, was surrounded by a halo of lighter than normal retinal tissue, along with an area of increased pigmentation which occupied a region as large as one disc's diameter. There was a large central scotoma to correspond with the macular defect.

CASE 17.—When this soldier, aged 23 years, was 13 years old, he had watched an eclipse with his right eye for a period close to half an hour, keeping his left eye closed, and not using any protective method over his right eye. Vision at present was 20/400 in the right eye and 20/30 in his left eye. Although a

disturbing after-image existed after this experience, the patient had never investigated the cause of his visual impairment, just disregarding vision in his right eye and using his left for central fixation. Examination of the right fundus showed a comma shaped small hole of punched out character with a series of three conjoined smaller holes lying just nasally and below. There was no pronounced halo or depigmentation phenomenon.

CASES 18, 19, 20 and 21 are all cases of gazing into an eclipse at approximately 12—15 years of age, closing one eye and looking through self-smoked glasses. Case 20 varied the procedure by gazing through a stenopaic slit in a cardboard. The time interval of exposure varied from five to twenty minutes. The macular lesions consisted of small polymorphous and multiple holes, surrounded by a halo and containing small yellowish central spots within the holes. In each case the story was the same—an eclipse was viewed through self-smoked glasses, keeping one eye closed and becoming aware of a distinct visual disturbance subsequently, which for one reason or another was not investigated or explained.

CASE 22.—This soldier had lived in Idaho all his life and he was able to recall several "bouts" of so-called snow-blindness, which he experienced in his early childhood. These were bilateral, acute episodes, associated with excessive photophobia, tearing and smarting, which usually lasted for several days during which time the patient was unable to see very well. He had regarded these attacks as typical cases of snow-blindness and thought very little about them. He also recalled many instances in his early life of watching the sun and viewing an eclipse through smoked glasses, although he is not very familiar with any symptoms which may have followed these experiences. There were many occasions, too, in which he had exposed his eyes to the direct rays of the acetylene welding torch, but cannot remember that any harm was produced by such an act. Upon induction his vision was found to be 20/20 in each eye. About eight months ago while in Alaska and while working outdoors he fixed his gaze upon a reflecting white surface for several minutes, and thereafter experienced an after-image of golden yellow in each eye which persisted for more than a week and was associated with intense tearing, blepharospasm and burning. At first he thought these symptoms were similar to those he had experienced in his early youth in Idaho, but when these symptoms left a permanent defect in his vision he felt that something further had developed. He did not seek aid until his return to the United States about one month ago, at which time his fundi revealed bilateral typical macular holes of small calibre with surrounding halos. Vision in the right eye was 20/40 and in the left eye 20/25. The hole in the right eye resembled the map of India in shape, that of the left eye was much smaller. Scotomata were present in both eyes. In the right eye besides a central lesion there was a pronounced downward elongation of the blind spot.

Since writing the above paper an excellent article has appeared by D. O. Harrington in the American Journal of Ophthalmology (Vol. XXIX, No. 11, November, 1946, p. 1405) on "the autonomic nervous system in eye disease," in which the subject of "solar retinitis" is taken up. This author concludes that cases of this sort are unusual and that "these lesions are thought to be the results of localised vasospasm of retinal arterioles and capillaries in the macula initiated by thermal or infra-red rays and terminating in a small hole." From his conclusions I believe Harrington indicates that this end result is part of the clinical picture of a "vaso-neurotic diathesis in an autonomically unstable person." To this conclusion I would like to add just one fact—namely that I have observed over 500 cases of these small macular holes in "coloured" troops, none of whom were vaso-neurotic and every-one of whom was exposed to the direct action of the sun's rays.