Conclusion

The growth described is a typical endothelioma. There is some evidence suggestive of the presence of a thin layer of growth which lies between the dural and pial sheaths on the nasal side of the nerve and that this layer of growth, wrapped around the nerve superficial to its pial sheath, much thicker on the temporal side, has on that side grown more rapidly and spread more freely into and through the dural sheath. On the other hand, it may quite well be stated that the growth arose as an extra-dural endothelioma, or from lymph channels in the dural sheath, and that it extended inwards into the subdural space. The neoplasm has extended to such dimensions that a decision as to this is impossible. However, as shown in a previous paper⁽²⁾, an endothelioma arising in the endothelium of the subdural space, either superficial or deep to the arachnoid sheath, may at an early stage spread into and through, and largely destroy the arrangement of the dural sheath. Further, the subdural space is a recognized source of endothelioma of the optic nerve. It is probable, therefore, that the growth in this case originated from the endothelium of the subdural space.

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GLAUCOMA SECONDARY TO CHOROIDAL SARCOMA. THE TREATMENT OF PAINFUL BLIND GLAUCOMATOUS EYES

BY

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THE occurrence of several cases of sarcoma of the choroid in eyes that were excised on account of pain and loss of vision with glaucoma, at Moorfields Hospital, led to the investigation of the incidence of new growth of the choroid in glaucomatous eyes that were excised during a period of eleven years from 1903 to 1911 and 1922 to 1924. Acknowledgments are due to the following surgeons for their kind permission to report their cases:—Mr. W. Lang; Mr. Flemming; Mr. Lawford; Mr. Spicer; Mr. Collins; Mr. Worth; Mr. Fisher; Mr. B. Lang; Mr. Whiting; and to Mr. Greeves for facilities given for the examination of sections

of five of the cases, from the pathological collection of the late Mr. George Coats. Cases of Mr. Morton and Mr. Hancock are also included.

During the period mentioned, there were 402 excisions performed for glaucoma. Of these cases 40 (10 per cent. approx.) were found, pathologically, to contain sarcoma of the choroid. In 21 of these cases, the growth was diagnosed on clinical grounds before excision. In three cases, a growth was suspected, but in the remaining 16, clinical notes of the cases fail to reveal any suspicion that a new growth was present. Out of these 16 cases, the operation of iridectomy was performed in three, and posterior sclerotomy followed by iridectomy in one. These four eyes, upon which operation had been performed, were subsequently excised, three on account of failure of the wound to heal and gaping thereof, and the fourth after a return to Hospital with detachment of the retina. The remaining 12 of these 16 eyes were excised on account of absolute glaucoma.

The descriptions which follow consist of abstracts from the clinical notes in the Moorfields Hospital records and of abstracts from the pathological reports of the Curator. The pathological statements have been verified during the composition of this paper by microscopic examination of sections in every case. The numbers are those of the pathological records in the Royal London Ophthalmic Hospital. The abstracts have been made as brief as possible, allowing for the inclusion of evidence as to glaucoma and evidence as to new growth of the choroid and its type. The term "spindle-celled sarcoma" is used to denote growths which have a markedly elongated spindle-shaped nucleus, and also those with an oval or oat-shaped nucleus.

No. 6750 (Fig. 1). J.W., aged 49 years, admitted with intense pain in left eye.

Examination showed: much injection of conjunctiva; ring keratitis and general haziness of cornea; no anterior chamber; anterior synechiae of margin of pupil; lens displaced forwards and opaque; no perception of light; tension plus 3; no view of fundus could be obtained; (Feb. 25, 1904) left iridectomy was performed; (Nov. 26, 1904) wound bulging, much injection; no anterior chamber; pain present; (Nov. 27) wound flattened; no anterior chamber; (Nov. 29) left excision.

Sagittal section left globe shows anterior chamber absent; lens and iris pressed against cornea, angle of chamber closed; retina detached. Choroid contains a large melanotic round-celled angiosarcoma; subchoroidal haemorrhages.

(No section of this specimen remains which shows the full extent of the growth and its base. The only section obtainable was that illustrated in which the summit only appears.)

No. 6785 (Fig. 2), C.W., age not noted; left eye injured with a whip 18 years ago. This eye was operated on three times, and inflamed two years ago. Painful for the last two weeks.

Examination showed: left eye very tender; cornea bulging, and vascular scars; anterior chamber deep; coloboma upwards; aphakia; no perception of light; tension plus 1; no view of the fundus obtained; right eye normal; (April 26, 1904) left eye excised.

Vertical section left globe shows: irregular anterior chamber; angles blocked; iris adherent widely at the periphery on both sides; lens shows peripheral remains after extraction; capsule is folded; retina detached and degenerated; there is a choroidal melanosarcomatous growth, the cells of which are large oval, or spindle shaped.

No. 6976 (Fig. 3), F.F., aged 68 years, a history of defective vision in the right eye for six months, with halos. Three weeks before admission severe pain and vomiting. Eye painful since.

Examination of right eye showed: conjunctival and ciliary congestion; cornea hazy; shallow anterior chamber; pupil dilated, fixed, irregular; iris atrophic; vision, no perception of light; tension plus 3; no view of fundus could be obtained; left eye normal; (Feb. 21, 1905) right eye was excised.

Horizontal section of the globe shows: blocked corneo-iridic angles on both sides. Haemorrhage in anterior chamber. Retina is totally detached. About one disc diameter to temporal side of papilla is a choroidal growth with a broad base and a round head. There is no perforation through the sclera. The tumour is a leuko-sarcoma containing oval cells.

No. 7025 (Fig. 4), H.W., aged 66 years, history of rapidly failing sight in the left eye. For the last three weeks she could scarcely see at all.

On examination: there was intense ciliary and conjunctival congestion with conjunctival chemosis; a large shallow and infiltrated ulcer at the lower part of the cornea; lens opaque; vision, no perception of light; tension plus 2; no view of the fundus could be obtained; right eye normal; (May 19, 1905) left eye was excised.

Sagittal section of left globe shows a large hypopyon in anterior chamber over back of area occupied by ulcer. Anterior chamber fairly deep. Angles blocked on both sides. Retina detached. In the posterior part of the eye covering papilla is a large spindle-celled sarcoma, deeply pigmented.

No. 7027 (Fig. 5), E.R., aged 57 years, right vision failed very suddenly without pain in December, 1904. Eye became inflamed and painful one month ago.

FIG. 1 (6750)

FIG. 2 (6785)

FIG. 3 (6976)

FIG. 4 (7025)

FIG. 5 (7027)

FIG. 6 (7041A)

FIG. 7 (7312)

FIG. 8 (7313)

FIG. 9 (7368)

FIG. 10 (7862)

FIG. 11 (7906)

FIG. 12 (7986)

FIG. 13. (8238)

FIG. 14 (403)

FIG. 15 (416)

FIG. 16 (656)

NOTE *re* ILLUSTRATIONS.

The drawings are made with the help of a projection lantern. The shaded portion represents the size and position of the choroidal sarcoma. The variation in shape is due to distortion of the specimen during preparation of sections. Of No. 6785 (see Fig. 2), no section with more than a part of the growth in the section was obtainable. The *r* signifies retina, the letter *w* wound of operation.

Examination showed: right ciliary and conjunctival injection; cornea very hazy and oedematous; remains of old keratic precipitates; medium anterior chamber; pupil dilated, oval and inactive; lens opaque; no perception of light; no view of fundus obtained; tension plus 3; left normal; (May 10, 1905) right eye excised.

Horizontal section right globe shows: corneo-iridic angles occluded by adhesion of iris to back part of cornea as far as the ending of Descemet's membrane. Retina detached from papilla to ora serrata. On the temporal side of disc is a melanotic new growth with an expanded base, a constricted neck, and a round head. It is a spindle-celled deeply pigmented sarcoma. There is no evidence of extra-ocular extension or involvement of nerve.

No. 7041a (Fig. 6), S.S., aged 60 years, had misty sight with halos for six months before admission. Four days previously sudden attack of severe pain in right eye.

Examination showed: right congested; cornea hazy; shallow anterior chamber; pupil dilated, irregular and fixed; tension plus 2; left eye normal; (June 2, 1905) right iridectomy; (June 3, 1905) severe pain, vomiting, tension plus 3; (June 9, 1905) wound bulging, tension plus 1 or 2; painful and injected, no keratic precipitates; right eye excised.

Report on microscopic section: edge of corneal wound infiltrated; no trace of healing; iris prolapsed in the wound; angles are slightly blocked, not beyond spaces of Fontana. There is a tumour situated above the disc and measuring 7.5 mm. at base and 11 mm. in height. It is covered by remains of choroid and greatly degenerated retina which contains tumour cells. Tumour is a deeply pigmented sarcoma containing small irregular cells tending to be spindle-shaped. Nerve is atrophic. Retina is totally detached.

No. 7312 (Fig. 7), R.S., aged 39 years, history of pain and trouble in left eye on and off for twelve months. Quite blind for three months (August 23, 1906).

Examination showed: left ciliary and conjunctival injection; cornea steamy all over and covered with blood-vessels; no keratic precipitates; pupil dilated, inactive; vision, no perception of light; tension plus 2; no view of fundus obtained; (August 27, 1906) left eye excised.

Horizontal section shows: occluded angles; new formed tissue on anterior surface of iris; umbrella-shaped retinal detachment. On the nasal side of the nerve is a melanotic sarcoma 14 mm. at base, 8.5 mm. in height. It reaches from equator to nerve and invades the surface of latter. Tumour is a large spindle-celled sarcoma with comparatively scanty pigment.

No. 7313 (Fig. 8), M.H., aged 53 years, left glaucoma for three months.

Examination showed : (August 18, 1906) ciliary and conjunctival injection ; cornea hazy, enlarged veins below ; many fine pigmented keratic precipitates ; pupil dilated, inactive, and discoloured ; vision, no perception of light ; tension plus 2 ; dull fundus reflex, no details seen ; (August 20, 1906) left iridectomy ; (August 23, 1906) very shallow anterior chamber ; wound bulging ; (August 27, 1906) fair anterior chamber ; tension lower ; (August 30, 1906) leakage ; very shallow anterior chamber ; (August 31, 1906) tension normal ; injection, photophobia, and lacrymation ; anterior chamber leaking ; pigmented keratic precipitates ; tension below normal ; no view of fundus ; (Sept. 3, 1906) left excision. [The notes add “? new growth,” presumably on account of the visible mass involving the optic nerve (see Fig. 8).]

Sagittal section left globe shows : iridectomy wound above. Lens *in situ*. Angles adherent to beyond termination of Descemet's membrane. Umbrella-shaped detachment of retina. Over a large part of the posterior pole of the eye is an extensive sarcoma of flat type. There is a large extraocular extension which is connected with the intraocular growth through the lamina cribrosa and optic nerve. The cells are spindle-shaped, without any excess of pigment cells in the choroid, and none in the growth.

No. 7368 (Fig. 9), E.F., age not noted, left discovered to be blind twelve years ago. More than 20 attacks of pain and redness since. Right failing somewhat in past months.

Examination showed : left intense injection, photophobia, pain ; cornea hazy and invaded by deep vessels ; some keratic precipitates ; fair anterior chamber ; pupil semi-dilated and fixed ; vision, no perception of light ; tension plus 3 ; no view of fundus obtained ; right normal ; (Oct. 31, 1906) left eye excised.

Horizontal section of left globe shows : angles occluded. Lens *in situ*. Retina detached from nerve to ora serrata. On the nasal side there is an extensive tumour which commences a short distance in front of ora serrata and extends right on to the nerve entrance. Nerve is invaded by a mass with its apex at the cut end. Tumour is a spindle-celled melanotic sarcoma.

No. 7862 (Fig. 10), V.B., aged 64 years, had acute inflammation in the left eye one week ago.

Examination showed : right eye quiet ; left intense oedema of the upper lid with chemosis of conjunctiva ; circular marginal ulcer ; no anterior chamber ; vision, no perception of light ; tension plus ; no view of fundus obtained ; (April 4, 1909) left excised.

Horizontal section of left globe shows : anterior chamber contains haemorrhage. Lens forwards. Angles occluded. Retina detached. On the temporal side of disc a melanotic tumour of choroid projects into the subretinal space. There are areas of

necrosis and haemorrhage in the growth. No evidence of extra-ocular extension. Tumour is a melanotic sarcoma containing oval and spindle cells, and is deeply pigmented.

No. 7906 (Fig. 11), S.A., aged 66 years, right glaucoma and iritis.

Examination showed: (May 28, 1909) steamy cornea with posterior synechiae; tension plus 3; (June 1, 1909) right, intense injection; absolute glaucoma with steamy cornea; iris vascular; lens opaque; broad posterior synechiae; vision, no perception of light; tension plus 2; left normal; (June 9, 1909) right eye excised.

Horizontal section right globe shows: occluded angles. Retina is detached. In the posterior part of the globe is a large melanotic sarcoma, it lies above and over the nerve entrance and is more on the temporal than the nasal side. The tumour is a spindle-celled sarcoma with very little pigment.

No. 7986 (Fig. 12), A.S., aged 55 years, sudden loss of sight in left eye six months ago. Eye previously quite good; pain for last 14 days.

Examination showed: left intense injection; cornea bright; anterior chamber very shallow; pupil slightly dilated and fixed; iris very vascular; vision, no perception of light; no fundus reflex; tension plus 2 or 3; (Nov. 13, 1909) left eye excised; new growth projecting from sclera behind; (Dec. 1, 1909) left exenteration of orbit.

Horizontal section shows: angles occluded nearly as far as edge of membrane of Descemet. Atrophy of iris. Umbrella-shaped detachment of retina. On nasal side of disc stretching backwards from equator is a melanotic tumour of the choroid. Tumour cells are of various types, but mainly large polygonal. Tumour is insinuating itself between the lamellae of sclera in a zig-zag manner.

No. 8238 (Fig. 13), A.B., aged 47 years, left eye inflamed and painful for 10 days.

Examination showed: left eye much injected; cornea hazy; pupil semi-dilated and oval; no fundus reflex; vision, perception of light; tension plus 3; right eye normal; treated with hot bathing and oily eserine every half-hour; tension became slightly less and pupil smaller; (Nov. 15, 1910) left posterior sclerotomy and left iridectomy; (Dec. 1, 1910) left eye slightly injected; cornea bright; anterior chamber shallow; no fundus reflex; tension normal; vision, perception of light; (Dec. 5, 1910) discharged; eye white, tension normal; (Jan. 5, 1911) left moderately injected, cornea oedematous; iris discoloured; retina totally detached; no perception of light; tension plus 2; (Jan. 6, 1911) left eye excised.

Horizontal section shows: angle occluded on one side by apposition of iris to cornea. Large deeply pigmented growth

springs from posterior and inner part of choroid. Retina completely detached. Tumour is composed of polyhedral and round cells with varying amount of pigment.

No. 403 (Fig. 14), P.E., aged 69 years, history of pain in right eye for three weeks. Had never seen well with it. No history of injury.

Examination showed: marked ciliary and conjunctival congestion; cornea oedematous; anterior chamber shallow; lens opaque; tension plus 3; vision reduced to bare perception of light; no view of the fundus could be obtained; left eye normal; (Oct. 13, 1921) right eye excised.

Macroscopic description: horizontal section above the nerve. Anterior chamber reduced to a mere slit. Iris in contact with posterior surface of the cornea throughout the section. Retina totally detached and in contact with the lens. On the nasal side of the disc is a nodular mass projecting from the choroid. The mass is a deeply pigmented spindle-celled sarcoma of the choroid. (Histological microscopic section only included the marginal portion of the growth.)

No. 446 (Fig. 15), H.R., aged 38 years, failing sight in the right eye for three years. Completely blind for six months. Much pain for the last three months.

Examination showed: ciliary injection; hazy cornea; shallow anterior chamber; pupil semi-dilated and inactive; vision reduced to perception of light; tension plus 2; no view of the fundus could be obtained; left eye normal; (Nov. 24, 1921) right eye excised.

Horizontal section through the upper edge of the disc. Anterior chamber shallow. Complete detachment of the retina. A dome-shaped mass arises from the choroid and surrounds the disc. The growth is a spindle-celled melano-sarcoma.

No. 656 (Fig. 16), R.M., aged 67 years, severe and persistent pain in the left eye three days previous to admission. Twelve weeks previously had first similar attack. Several attacks since.

Examination showed: conjunctival congestion; cornea hazy and bullous; pupil inactive and semi-dilated; vision, no perception of light; tension plus 3; no view of the fundus could be obtained; right eye normal; (Sept. 13, 1922) left eye excised

Horizontal section above the optic nerve shows angles of the anterior chamber blocked at the extreme periphery. Iris and lens normal. Retina detached on the nasal side over the swelling. Choroidal tumour extending from 2 mm. posterior to the root of the iris back to the disc edge. Glaucomatous type of cupping. Swelling is a flat spindle-celled melano-sarcoma of choroid.

The result of this investigation has been to demonstrate that, without doubt, the occurrence of sarcoma of the choroid in cases

of blind painful glaucomatous eyes is something more than a rarity. On the contrary, the fact that among 402 cases in which glaucomatous eyes were excised, 16 (4 per cent. approx.) proved to contain sarcoma of the choroid, is a very definite indication of the considerable danger that exists in a patient in whom such an eye is treated by any means other than excision. Attention is drawn to the fact that this proportion (4 per cent.) concerns cases in which there was not the least suspicion of new growth, as exemplified by the fact that in four of these, operations were performed for the treatment of the glaucoma. Incidentally, the high percentage of cases of sarcoma in this total of glaucomatous eyes (10 per cent.) gives food for thought, in connection with the cause of glaucoma.

Summary and Conclusions

(1) Of 402 eyes excised on account of glaucoma, approximately 10 per cent. were found on pathological examination to contain a choroidal sarcoma; 4 per cent. were blind glaucomatous eyes in which there appears, from the clinical notes, to have been no suspicion of the existence of a new growth.

(2) Of these 16 cases of sarcoma of the choroid, 13 were spindle-celled, 3 were round or polygonal-celled, 12 were pigmented and 4 possessed but scanty pigment or were unpigmented.

(3) The average age of 14 of the 16 cases at the time of excision was 57 years, the maximum 69 and the minimum 39 years. No assistance is to be obtained, in the matter of the diagnosis, from a consideration of the age of the patient. In this series, the average age was well above the average age of appearance of sarcoma of the choroid (from 44.2 to 48.7 years⁽¹⁾) and near the middle of the age period of onset of congestive glaucoma (from 50 to 70⁽²⁾).

(4) *The treatment of cases of blind painful glaucomatous eyes should be enucleation*, especially if the glaucoma is unilateral, excepting in a few cases in which the media of the eye are sufficiently transparent to enable examination of the fundus oculi to be made. In such cases, if there be an obvious anterior detachment of the retina and if the presence of a new growth is not suspected or is doubtful, one of two procedures may be adopted as a preliminary to further surgical treatment:

(a) Scleral puncture into the space external to the detachment and ophthalmoscopic examination to ascertain whether the detachment (or retinal cyst) has diminished in size.

(b) Dissection of a scleral flap, with its apex placed anteriorly, made over the site of the detachment. Very cautious dissection and elevation of the flap is essential in order to avoid damage to a choroidal sarcoma, if one be present, and dissemination of growth cells.

AFTER-IMAGES OF DICHROMAT AND
ANOMALOUS TRICHROMAT

AFTER-IMAGES OF NORMAL

Of these two methods, the latter is likely to be the less dangerous.

In the event of the acquisition, by this means, of evidence of the presence of a growth, the eyeball should be enucleated immediately. If no such evidence be obtained, the wound may be closed and further operative treatment adopted for the glaucoma, if considered advisable, at a later date.

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THE COLOURS OF AFTER-IMAGES, FOLLOWING STRONG LIGHT-STIMULI

BY

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I. Introduction

THIS communication deals with the colours of after-images, following strong light-stimuli, as observed in absolute darkness. We will call these "original" after-images, whilst those modified by fresh light-stimuli will be named "induced" after-images. The observations and theories of former authors (Fechner⁽¹⁾, Plateau, Brücke⁽²⁾, Helmholtz⁽³⁾, Séguin, Burch⁽⁴⁾ and McDougall⁽⁵⁾) will not be discussed here as it is my intention to bring forth in this first communication mere facts, leaving theories for later.

For control of my results the conditions of examination should be identical. The observers must be familiar with physiological work, and their colour sense should be carefully examined. Observations must be carried out unilocularly and in absolute darkness. All influences that could distract the observer's attention should be eliminated. Some exercise is required as the periodical fading of the after-images is disturbing to the beginner. This phenomenon will disappear nearly entirely as a result of sufficient practice.

No pigment-lights were used. In examination with strong light-sources like direct sunlight and electric arc lamp the excess of ultra-violet rays should be absorbed by the use of colourless glass of sufficient thickness. Much care has to be taken that all after-images of previous light-stimuli have disappeared before starting a new experiment. The observations were registered by speaking in a dictaphone, and a metronome marked the time in