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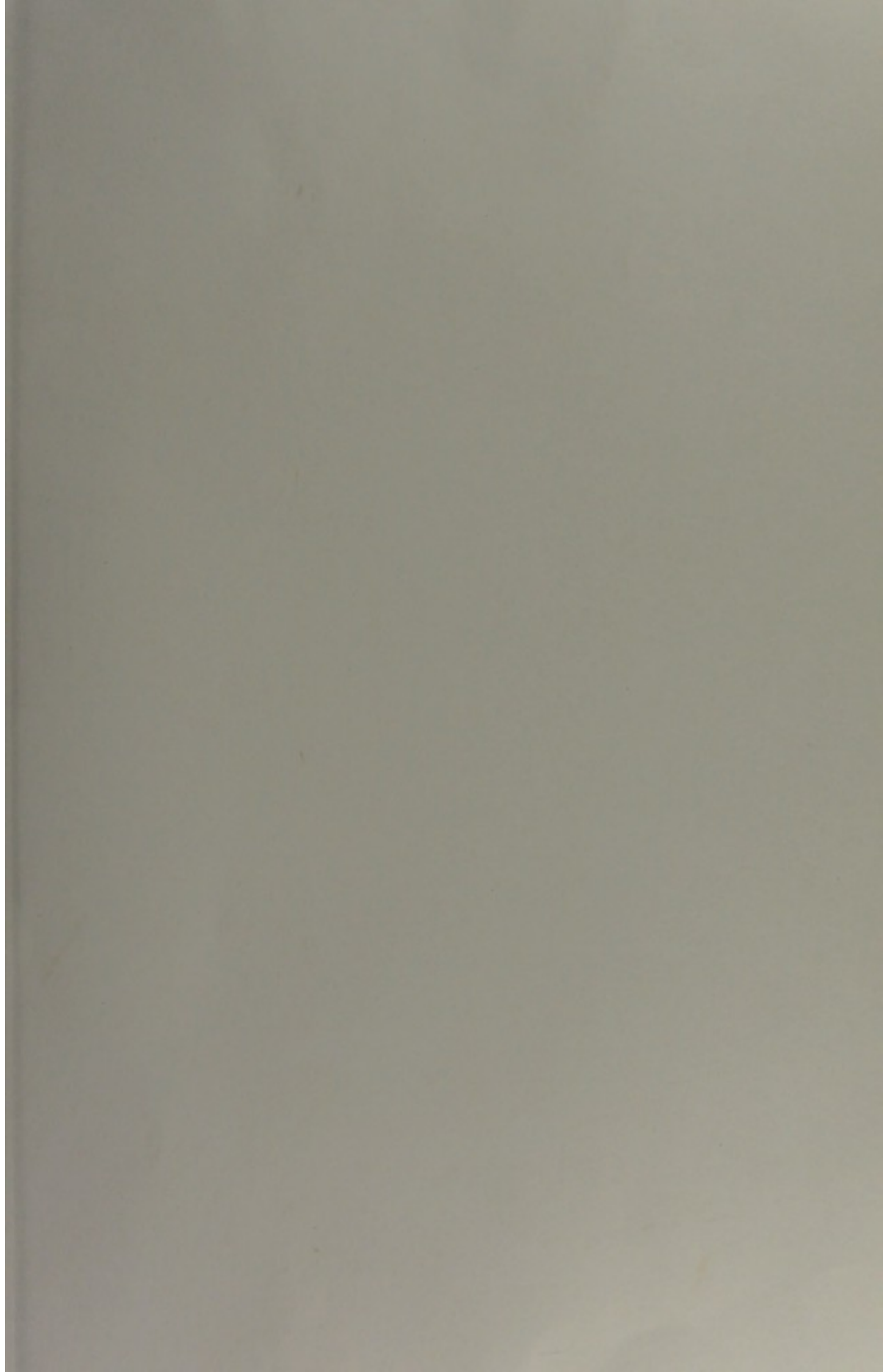
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On the minute anatomy of pyramidal cataract.

By E. TREACHER COLLINS.

HAVING recently examined microscopically six lenses with anterior polar opacities, or what are commonly called pyramidal cataracts, I thought it would be interesting to bring them before this Society, more especially as the cases form a series with relation to the date of the formation of the cataract and that of the excision of the eye. In all the cases there was either ulceration and perforation of the cornea or evidence that it had occurred. My six cases arrange themselves into three sets of two each. In the first set, containing Cases 1 and 2, of less than six weeks' formation and less than eight weeks' formation respectively, are shown the earliest changes in the formation of the opacity (Figs. 1 and 2). These consist in a localised proliferation and breaking up of the epithelial cells which line the hyaline capsule at the anterior pole; also, some disturbance and breaking up of the lens fibres in the neighbourhood. These changes were excited probably in all the cases recorded in this paper by the contact of the inflammatory products in the pupil incident on the ulceration of the cornea. As a consequence of the proliferation of the capsule cells, some elevation of the hyaline capsule over them has been brought about, and from the breaking up of the lens fibres some excavation of the lens substance beneath them has occurred.

In the second set, Cases 3 and 4, of about seven months' formation and one year and seven months' formation respectively, the débris of the broken-up cells and lens fibres has become condensed into the form of an almost structureless mass, showing a slight lamination, and having a few flattened epithelial cells stranded here and there in it (Fig. 3). What, however, makes the striking feature of distinction between this and the first set is, that situated between the portion which constitutes the opacity and the lens fibres there is a complete single layer of cells continuous on all sides with those lining the unaltered capsule, so that at the margin of the opacity the hyaline capsule and the epithelium lining it appear to part company, the former going in front of the opaque portion, and the latter behind it. It seems natural to suppose, from the examination of these specimens, that the exciting cause which brought about the disturbance at the anterior pole of the lens having subsided, the epithelium of the healthy part of the capsule grew in between and separated the opaque and degenerate portion from the unaltered lens fibres.

In the third set, Cases 5 and 6, of eleven and twenty-one years' formation respectively, the opaque part is very similar in appearance to that in the second set. It is somewhat more condensed, it has fewer flattened cells, and there is some calcareous deposit in it (Figs. 4 and 5). The marked characteristic of these two lenses is, that behind the opacity between it and the lens fibres is not only a layer of cells, but also a layer of hyaline capsule, so that at the margin of the opacity the hyaline capsule seems to split into two layers, one going in front of it and one behind, the epithelium which lines the unaltered capsule being continued on the posterior surface of the latter.

That the changes which give rise to pyramidal cataract are situated beneath the hyaline capsule was long ago pointed out by Stellwag von Carion, Müller, Rucke, Bauer, Dixon, and Hulke. That occasionally a hyaline layer is

met with behind the opacity as well as in front was mentioned by Becker, who considered that it had become split off by the intrusion of new material into the substance of the capsule.

More recently* B. Gener, jun., as the result of the examination of two fish's eyes, came to the conclusion that these hyaline layers were not split off the original capsule, but freshly secreted by the epithelial cells.

This latter view of their origin I am inclined to believe to be correct from the examination of my specimens. Because in six cases I find in those most recently formed there is no distinct layer separating the opaque part from the lens fibres. In those of longer duration a layer of cells is observed between them, which, as I have said, look as though they had spread in from the unaltered cells lining the capsule. And in two, in which several years had elapsed since the formation of the cataract, in front of the layer of cells is the layer of hyaline capsule, thicker in that of twenty-one years' than that of eleven years' duration. Also because the hyaline layer behind the opacity in Case 5 is a complete layer. I have examined numerous sections of it, but have been unable to find any gap in its continuity, through which the intrusion of the new material could have taken place.

It is sometimes observed that in cases of pyramidal cataract, in addition to the opacity at the anterior pole there is a second opacity a little depth in the lens substance, separated from the anterior one by some clear lens matter. A case of this sort was recently shown to me by Mr. Gunn.

The patient was a man, aged 24, who in infancy had had inflammation of the eye, which had left a nebula of the cornea.

Now the lens in this man's eye at the age of twenty-four is considerably larger than it was in infancy at the time he had the inflammation and the cataract was formed. That is to say, new cortical fibres have been laid on. These have

* v. Graefe's 'Archiv,' Bd. xxxvi, p. 255.

gradually separated the pyramidal opaque part from the portion of the lens which was in contact with it when the disturbance of the epithelium occurred. And if changes had occurred in that portion of the lens sufficient to render it permanently opaque this opacity would gradually appear to sink deeper and deeper as the lens increased in size.

It is always satisfactory, and says much for the truth of new observations, when they throw light on old ones which before seemed somewhat inexplicable. Mackenzie, in the fourth edition of his book, says, "In some cases we observe a single pyramidal speck projecting from the centre of the capsule. On operating I have sometimes found these specks to separate readily from the capsule on being touched with the needle, and to fall forward through the dilated pupil into the anterior chamber."

Mr. Hulke, after mentioning how the opacities are always found on the inner surface of the capsule, says,* "The slightest touch of the needle in the operation of solution sometimes suffices for the detachment of these little opaque cones, and this has been urged as an objection to the truth of the view I have just stated. I have seen it happen on several occasions, and have minutely examined the detached portion. It consists of a small disc of transparent capsule, to the inner surface of which the base of the little cone adheres; this is usually composed of tangled fibrous tissue, loaded with fatty matters and earthy salts; the fibrous tissue has its origin in a faulty development of the intra-capsular epithelium, and the transitional stages admit of easy demonstration."

Seeing that when the pyramidal opaque mass has formed the unaltered capsule cells from its margins grow in between it and the lens substance, and subsequently secrete a fresh layer of hyaline capsule beneath it, the fact that a touch with a needle easily detaches the opacity is readily explained, for it only completes a separation which nature has already partially effected.

* 'Ophth. Hosp. Rep.,' vol. i, p. 190.

This, therefore, can no longer be urged as an objection to the changes having occurred subcapsularly.

If it is permissible to draw suggestions as to embryological processes from pathological data, I think these cases throw some light on the mode of development of the capsule of the lens. There has been much difference of opinion on this point amongst embryologists of renown. They are not even agreed from which of the primary layers of the blastoderm it proceeds. The matter is thus briefly and tersely summed up in 'Quain's Anatomy,' 9th ed.:—"The origin of the capsule of the lens appears to be still somewhat doubtful. Lieberkühn, Arnold, and Löwe profess to trace it to a thin pellicle of mesoblast which at an early period passes in between the lens and the secondary ocular vesicle; but Kölliker and Kessler are of opinion that it is a cuticular deposit on the surface of the lens cells. Balfour is inclined to adopt the latter view, on the ground that the capsule seems to make its appearance before the introduction of the mesoblast has occurred."

If, as seems to me to be the case, the epithelial cells lining the lens capsule are capable, on the application of a morbid stimulus, of secreting a hyaline layer, identical in all points with the normal capsule, it seems reasonable to infer that the capsule itself is originally formed by such a secretion.

In conclusion, I wish to draw attention to and challenge a statement that has more than once been made, and was recently quoted at this Society, because it bears considerably on the causation of pyramidal cataract.

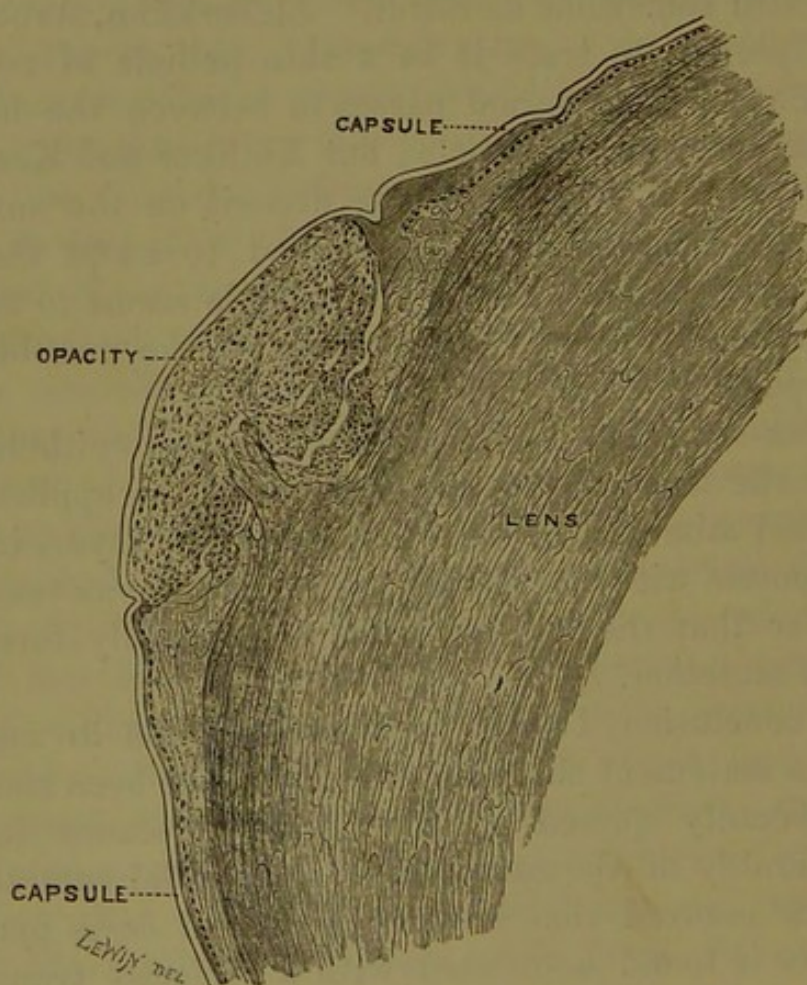
It is asserted that in the majority of cases pyramidal cataract is found associated with a perfectly transparent cornea.

The only way in which this assertion could be proved or disproved would be by the pathological examination of a large number of eyes with opaque corneæ. I question if this has been done by those who have made it. I expect that they have arrived at their conclusions from

a clinical standpoint alone, which is obviously unfair. Of the six cases which I bring forward to-night five had opaque corneæ, and in the other the cornea would have become opaque if it had been left. All six eyes were excised at the Moorfields Hospital during the years 1890 and 1891.

CASE 1, Reg. No. 3577.—*Pyramidal cataract of less than six weeks' formation.*—Olive V—, æt. $1\frac{3}{4}$, was admitted to

FIG. 1.



Section of lens in Case 1, showing the anterior polar opacity situated beneath the capsule.

the Moorfields Hospital under the care of Mr. Lang on December 18th, 1891. Her mother stated that six weeks previously she noticed a discharge from the patient's

right ear, and that a few days afterwards her right eye became inflamed, and had continued so in spite of treatment up to the present time. Her right cornea, with the exception of a narrow ring at its periphery, was found to have ulcerated away, the iris being left exposed with a greyish opacity filling the pupil.

Pathological examination after the excision of the eye showed that the grey opacity in the pupil was a pyramidal cataract. The remainder of the lens was clear, the vitreous of good consistency, and the retina *in situ*.

Microscopical appearances of the lens after hardening in Müller's fluid :—The opaque mass at the anterior pole of the lens has caused some elevation of the hyaline capsule beneath which it is situated. It is composed of a mass of proliferating capsular cells, those anteriorly being more flattened than the posterior ones. There is some disturbance of the anterior layers of the lens fibres, there being excavation of them beneath the opacity. The epithelium of the capsule on each side of the opaque mass is separated from the capsule itself for a short distance by what appears to be a homogeneous substance with vacuoles in it. It is probably coagulated albuminous fluid.

CASE 2, *Reg. No. 3146. Pyramidal cataract of less than eight weeks' formation.*—Joseph P—, æt. 10 months, was admitted to the Moorfields Hospital on June 2nd, 1890, under the care of Mr. Tweedy.

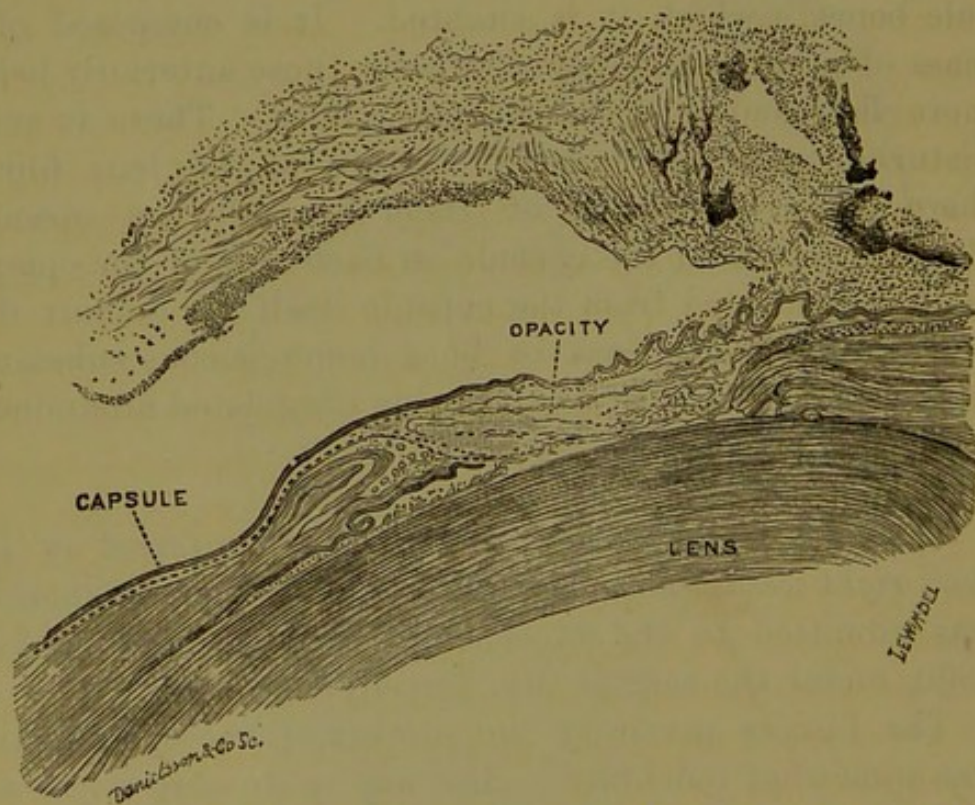
The history given by the mother of the eye affection was somewhat indefinite. She was quite sure there was nothing the matter with his eyes for the first eight months of his life. Soon after his right eye was first noticed to be "bloodshot" he was taken ill with what was called "brain fever," and was in bed six weeks, during which time the eye appears not to have been examined. Upon examination the right cornea was found opaque and bulging with new vessels in it. It had apparently recently perforated. The left had a leucoma in the lower

and inner part with a red patch in the centre, and adhesion of iris to it. The right eye was excised.

Pathological examination.—The cornea is thickened, and has the iris adherent to it. There is a slightly raised opacity at the anterior pole of the lens; the remainder of it is clear. The vitreous is of good consistency. The retina is *in situ*, and has a circle of hæmorrhages in it around the optic disc. This latter, as well as the choroid, appears healthy.

Microscopical appearances.—The cornea is much infiltrated with inflammatory cells, more especially in the

FIG. 2.



Section showing the anterior polar opacity in Case 2 beneath a wrinkled capsule, and inflammatory products in the pupil external to it.

centre, where the iris is adherent, and where there is some uveal pigment far in its substance. There has evidently been perforation. There is a considerable amount of inflammatory exudation in contact with the lens capsule anteriorly.

At the anterior pole of the lens the capsule is much wrinkled, and on its inner surface is some granular material with layers of epithelial cells in it. The patch thus composed is thickest in the centre, and gradually becomes thinner at the edges. There is some excavation of the lens fibres beneath it, and some breaking up of them into hyaline globules. The capsule on each side of this patch is lined by its epithelium in the normal way.

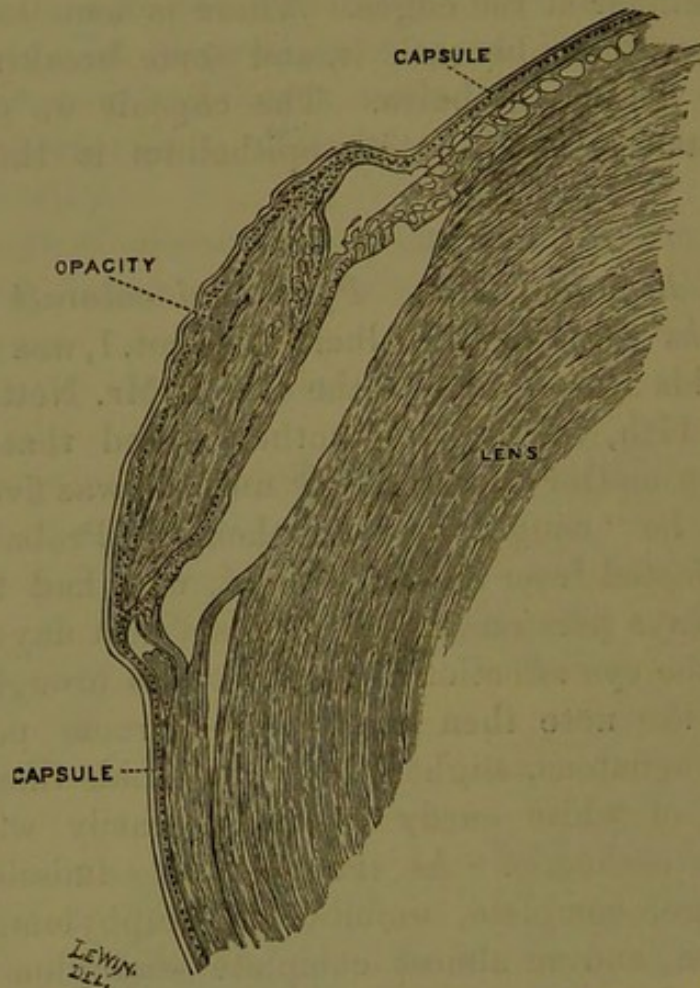
CASE 3. *Reg. No. 3332. Pyramidal cataract of about seven months' formation.*—Albert W—, æt. 1, was admitted to Moorfields Hospital under the care of Mr. Nettleship on February 17th, 1891. His mother stated that he had nothing the matter with his eyes until he was five months old; then he “caught cold in them.” Probably they became infected from an elder child, who had hers bad for a few days previously. On the seventh day after the onset of the eye affection the patient was brought to the hospital; the note then made was—Corneæ perforated and staphylomatous, slight discharge. Lids lined with a thin layer of white curdy substance, easily wiped off. Child very cachectic. At the time of admission there was a large, complete, umbilicated staphyloma of the right cornea, and an almost complete staphyloma of the left. The right eye was excised the following day.

Pathological examination.—The cornea is opaque and much thickened, more so at each side than in the centre. The iris is much atrophied, and intimately adherent to the posterior surface of the cornea. The lens is *in situ*; it has a slightly raised opacity at its anterior pole, otherwise it appears normal. The vitreous is somewhat thin in consistency. The retina has some rucks in it.

Microscopical appearances of lens after hardening in Müller's fluid:—The opacity at the anterior pole is situated beneath the hyaline capsule, but has a layer of cells continuous with those lining the capsule elsewhere behind it, that is between it and the lens substance; so

that at the margin of the opacity the lens capsule and its lining epithelium part company.

FIG. 3.



Section of the lens in Case 3, showing a layer of cells continuous with those lining the capsule elsewhere beneath the opacity and the hyaline capsule in front of it.

The opaque part itself is made up of homogeneous substance irregularly laminated, with groups of flattened, epithelial-like cells scattered through it. There is a slight disturbance of the lens substance underlying the opacity; elsewhere it appears normal.

CASE 4. *Reg. No. 3483.*—*Pyramidal cataract of about a year and seven months' formation.*—Olive T—, æt. $1\frac{1}{2}$, was admitted to Moorfields Hospital under the care of

Mr. Tweedy on August 27th, 1891. His mother stated that his eyes were all right when he was born, and were not affected until he was four months old, when they commenced to discharge. Just previous to their coming bad he had had a discharge from his nose. Both corneæ were found to be staphylomatous and leucomatous, the left more so than the right. The tension of the left eye was increased; it was excised the day following his admission.

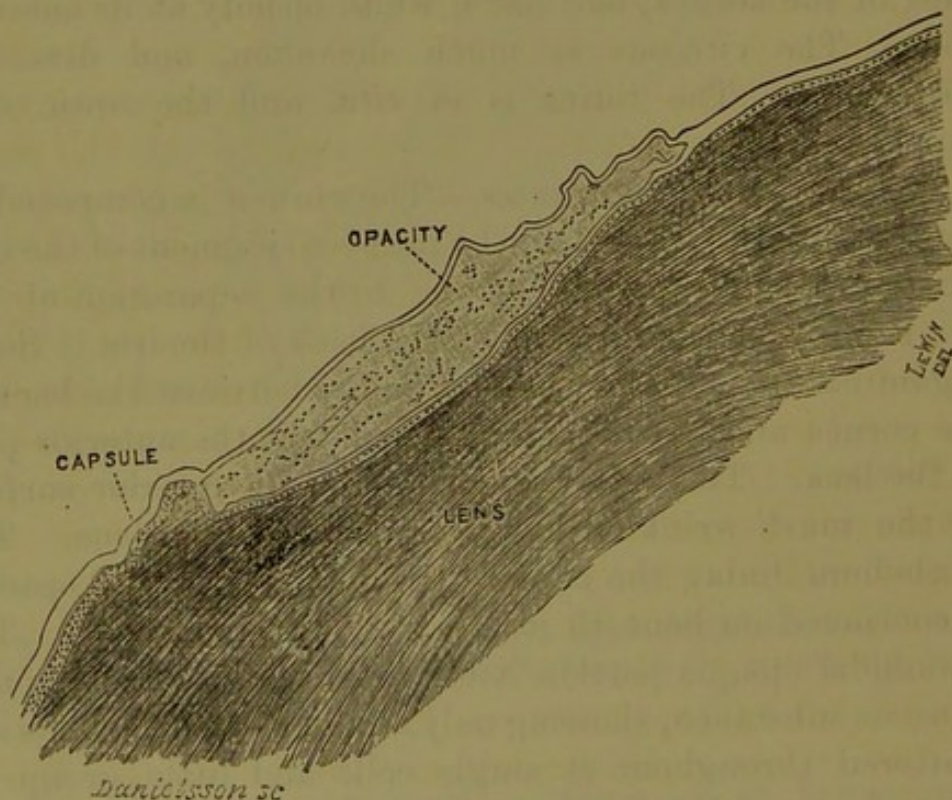
Pathological examination.—The whole cornea is very thick; its posterior surface is lined throughout by atrophied iris tissue. The lens lies in contact with the iris on the back of the cornea, and has a white opacity at its anterior pole. The vitreous is much shrunk, and detached posteriorly. The retina is *in situ*, and the optic disc cupped.

Microscopical appearances.—The cornea is composed of dense cicatricial tissue, lined by the uveal pigment of the iris. There are some spaces left due to the separation of the two layers of uveal pigment on the back of the iris. Some organised inflammatory exudation lies between the back of the cornea and the pyramidal opacity at the anterior pole of the lens. This latter is covered on its anterior surface by the much-wrinkled hyaline capsule of the lens. The epithelium lining the capsule at the sides of the opacity is continued on beneath it as a single row of cells. The pyramidal opaque portion itself consists of a nearly homogeneous substance, showing only a faint striation. This has scattered throughout it single cells and little groups of cells of an epithelial type. The fibres of the lens show signs of degeneration, and have a few patches of calcareous deposit in them.

CASE 5. *Reg. No. 3517. Pyramidal cataract of eleven years' formation.*—Elizabeth F—, æt. 18, was admitted to Moorfields Hospital under the care of Mr. Lang on October 4th, 1891. She stated that her left eye first became inflamed when she was seven years old. A note on a hospital

letter dated January 23rd, 1882, says she then had a staphyloma of the left cornea, and that an iridectomy was performed. Twelve days previous to her admission to the hospital she had a blow on her left eye, which had caused it to become inflamed and painful. On examination the lower two thirds of the cornea was found to be staphylomatous and leucomatous, with some calcareous deposit in it. The upper third was apparently normal. There was a coloboma in the iris upwards, and an opacity at the anterior pole of the lens. Her right eye was unaffected.

FIG. 4.



Section of the lens in Case 5, showing a complete layer of hyaline capsule lined by cells behind the anterior polar opacity, and a layer of hyaline capsule without cells in front of it.

Pathological examination.—The whole of the staphylomatous part of the cornea is lined by much atrophied iris tissue. Above, the iris has been removed well up to its periphery. The lens, besides having an opacity at its anterior pole, is somewhat altered in shape, being narrower

above than below. The vitreous is shrunken and detached posteriorly. The retina is *in situ*.

Microscopical appearances of lens.—There is a shallow depression in the lens substance at its anterior pole beneath the opacity. The hyaline capsule is continuous over the anterior surface of the opacity. There is also in all the sections examined a thin unbroken hyaline layer behind the opacity, which is lined by a single row of epithelial cells continuous with the cells lining the capsule elsewhere. The opaque part is thus contained between two layers of capsule, the anterior being a little thinner than the normal capsule, and the posterior very much thinner. The opaque substance itself consists of nearly homogeneous slightly granular material, which in places shows a faint lamination, and has in it some epithelial-like cells with well-staining nuclei, and some calcareous granules. The remainder of the lens appears healthy.

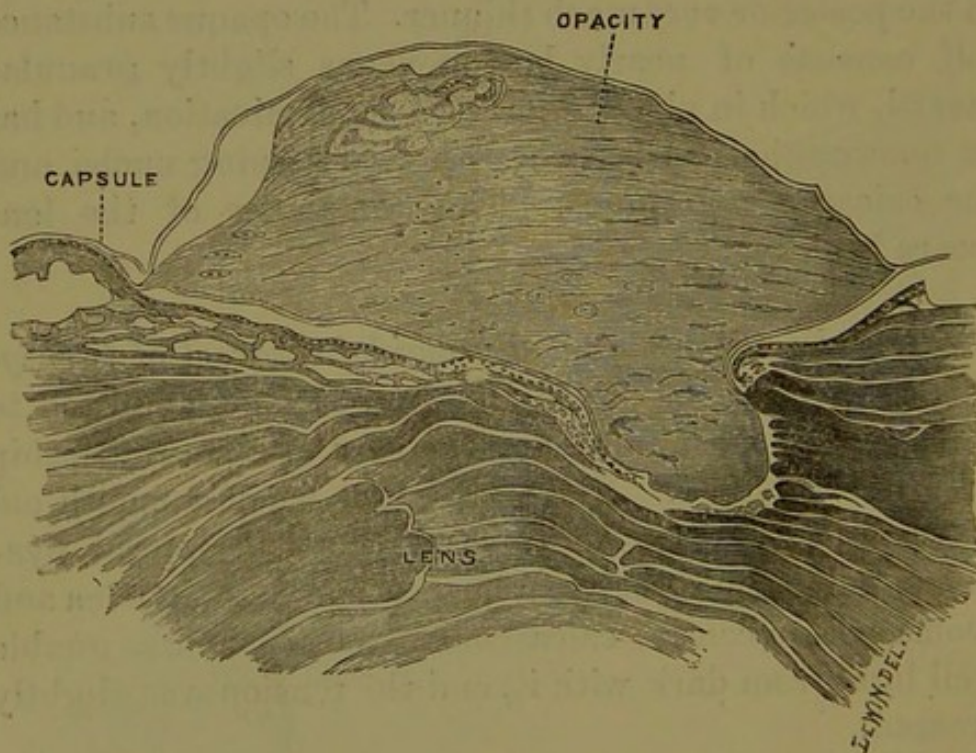
CASE 6. *Reg. No. 3388. Pyramidal cataract of twenty-one years' formation.*—Rose M—, æt. 21, was admitted to the Moorfields Hospital under the care of Mr. Nettleship on April 17th, 1891. She stated that when a month old she “caught cold” in both eyes. She had lateral nystagmus, and in the right eye a large corneal staphyloma and leucoma with a central calcareous patch. She was unable to tell light from dark with it, and the tension was slightly increased.

In her left eye the cornea was clear, and $V. = \frac{6}{9}$, and J. 1 at 22 cm. The right eye was excised the day following admission.

Pathological examination.—The whole iris is intimately adherent to the posterior surface of the cornea, and very much atrophied. There is a large posterior chamber. The lens is somewhat small; it is situated in its normal position, and has a white raised nodule at its anterior pole. The vitreous is shrunken. There are patches of atrophy in the choroid. The retina is *in situ*, and the optic disc cupped.

Microscopical appearances of lens.—At its anterior pole is a mass partly raised above the surface, partly dipping down into the substance of the lens. It has a hyaline layer of lens capsule, somewhat thinner than the normal capsule in front of it, also a layer of hyaline capsule of about the same thickness behind it. The capsule at the margin of the mass seems to divide into these two. The epithelium which lines the unaltered capsule is continued as a single row of cells on the posterior surface of the layer behind the mass. The mass itself has a laminated struc-

FIG. 5.



Section of the lens in Case 6, showing a layer of hyaline capsule lined by cells behind, and one of equal thickness without cells in front of the anterior polar opacity.

ture ; there are a few cells in it of an epithelial type, and at the anterior part there is some calcareous deposit. Where it dips down depressing the lens substance there is some irregularity of the lens fibres. There are also some irregular hyaline masses between the fibres in the cortex of the lens at its sides. (March 10th, 1892.)



