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ON THE PATHOLOGICAL ANATOMY OF LAMELLAR OR ZONULAR CATARACT.

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Opportunities of examining crystalline lenses affected with lamellar or zonular opacity are so few, that it seems worth while to record the results of the examination of three lenses (from two patients) which have come into my hands as Curator of the Hospital Museum.

Case 1.—Thomas B., æt. 44, shoemaker, admitted to the Royal London Ophthalmic Hospital under Mr. Nettleship's care on November 5th, 1886.

His history so far as ascertained was that he had never had good sight, that he had been unable to obtain spectacles which were of any assistance to him, and that he liked to shade his eyes, as he could then see better. He thinks his sight has become rather worse in the last 10 years.

He is the fourth child of six; his brother and four sisters have no defect of sight. He is married and has eight children, all of whom are healthy and have good sight.

On admission, V. R. $\frac{6}{60}$, 16 J. L. $\frac{6}{60}$, 16 J. Cornea, pupil, and anterior chamber normal in each. T. n. In the lens of each eye, a fairly dense typical lamellar opacity. Teeth much discoloured and irregular from loss of enamel. History, concerning fits during childhood, not known.

On November 6th the lens of the *right* eye was extracted through an upward section. The capsule was opened by incision near its upper edge, and the lens came out nearly complete. The wound healed well, and patient left the hospital November 24th.

After needling of some opaque capsule in the pupil, the vision of this eye was $\frac{6}{18}$ and 1 J. Patient returned in February, 1888, for operation on the left eye, the sight of which had not altered in the intervening 14 months.

On February 4th, 1888, the lens of the left eye was extracted

in its capsule. This eye also recovered well from the operation, and its vision with correcting glasses was two months later $\frac{6}{24}$ and J. 6.

Both lenses were treated in the same way, *i.e.*, carefully hardened in Müller's fluid for some weeks; transferred to weak and subsequently strong alcohol; embedded in celloidin. Sections were made in an antero-posterior direction; the staining reagents used were hæmatoxylin (Ehrlich's formula), alum-carmine, and cochineal; a number of sections were mounted unstained, and proved more useful than the coloured ones to exhibit the changes described below.

Right lens (fresh). The outline is irregular, the capsule and some of cortical layers are wanting. The anterior surface is marked by the notch cut by the cystitome, the posterior surface by its somewhat greater convexity. The transverse meridians of the lens measure 8 mm. and 8·25 mm. respectively, so that it has a slightly oval shape. The lamella of opacity is plainly visible, is very thin, and exhibits tiny spokes jutting out from it. As nearly as can be ascertained in the present condition, it measures 5·25 mm. transversely. The portion of lens outside the lamella is fairly clear and not very hard.

Microscopical Examination.—The most noticeable feature in the sections of the lens is the difference in appearance between the nuclear and cortical parts (Plate I). Beyond some separation of the fibres and the tearing of the outermost layers which occurred during the extraction, there is no noteworthy change in the cortical layers. The nuclear portion of the lens, however, exhibits very evident change, though as will be seen from what follows, it is doubtful to what extent these changes are pathological, and to what extent artificial, the result of the fluids employed in the preservation of the specimen.

This central area (Plate I) is very similar in shape to the whole lens, and its outlines are almost parallel with those of the lens; it is, however, rather nearer the posterior than the anterior surface; this may be the result of some of the posterior cortex of the lens remaining adherent to the capsule during the extraction. This area measures (in sections made through the middle of the lens) 2·325 mm. antero-posteriorly, 5 to 5·25 mm. transversely. It contains very numerous, irregularly shaped

spots and patches, which vary considerably in size, and are generally larger and less closely packed in the central part than towards the boundary of this area. These small spots become coloured by staining fluids to about the same degree as the lens fibres; they have an almost homogeneous appearance, and look like particles of very fine sand scattered over the lens fibres; they are not, however, at all raised above the level of the fibres. These particles exhibit a somewhat concentric arrangement as if following the layers of lens fibres. They vary in size from 0·0125 mm. to 0·025 mm., and their shape is quite irregular, some are circular, others have a dentate border. In unstained sections they are bright and highly refracting. It is very difficult to give a good representation of them in a drawing.

Although this central area is very distinct from the cortical part, there is in this specimen no continuous line separating the two parts of the lens. Here and there, however, are fragments of such a line of demarcation which can easily be supposed to be parts of a lamella in the lens, in the continuity of which there are breaks. Outside this line, especially anterior to it, there are several irregular patches of degeneration in the lens fibres, some of which project towards the cortex, and which perhaps are the representations of the spokes seen during life. They are not evident in Plate I, except on the anterior surface of the dotted area. The boundary line between the central and peripheral areas has a peculiar appearance not unlike that of a twisted rope, and its edges are slightly serrated; it varies in thickness a little, its measured diameter being from 0·0125 mm. to twice that thickness. The lens fibres have a decided tendency to split along this line, as though it formed a layer of degeneration, or of some change which reduced the adhesiveness of the adjoining layers.

In a few sections there is but little trace of this boundary to be seen, while in others it can be traced almost all round the central area, though frequently interrupted by short breaks. At the lower extremity in Plate I, there is an indication of a double line. It becomes coloured to almost exactly the same degree as the rest of the lens. The dots or granules in the central part reach generally quite up to this line, but do not extend beyond it.

Left lens (fresh.) Capsule entire and shape of lens about

normal. Its diameters measure 9 mm. transversely and 5 mm. antero-posteriorly. The lamellar opacity which shows very plainly is as nearly as can be measured 4·5 mm. in width. The rest of the lens is nearly if not quite clear, with the exception of a small opacity on the capsule near the equator.

Although the reagents employed, and the time taken in preparing this lens for examination, were as nearly as possible the same as in the case of its fellow, the results were much less satisfactory. After imbedding in celloidin the lens was divided antero-posteriorly into two halves, and sections of each half were made; those nearest the cut surface were not successful, so that I have no section which passes exactly through the centre of the lens and of the opaque lamella.

Microscopical Examination.—In this, as in the right lens, there is a central area of almost the same shape as the lens, which presents appearances very different from the cortical part. It contains very numerous small spots similar in size and appearance to those described above. The cortical layers of the lens exhibit marked changes which are almost entirely if not entirely due to the action of the hardening reagents. There are in places fragments of a boundary line between the nuclear and cortical areas, resembling in appearance that described in the other lens, but there is apparently much less of it. On its outer side, but close to it are several areas in which the lens fibres appear interrupted by a small nearly homogeneous patch, which projects a little towards the capsule of the lens. These patches, which probably represent the spokes seen on the zonular opacity during life, have not the appearance of post-mortem change, but more closely resemble the rope-like line which divides the nuclear from the cortical area.

The lens capsule and the sub-capsular epithelium exhibit no changes.

Altogether, the results of the examination of this lens are not satisfactory. This is, I think, simply due to the fact that the process of hardening produced considerable change in the lens, possibly on account of the impermeability of the capsule.

Case 2.—Ann C., æt. 30, admitted to the Royal London Ophthalmic Hospital, under Mr. Tweedy's care, on April 27th, 1888, suffering from lamellar cataract.

Unfortunately no particulars were entered in the in-patient notes, as to her history or the acuteness of sight at the date of admission.

The lens of the left eye was extracted on the day of admission, through an upward sclero-corneal incision. The lens capsule was divided at the upper periphery and the lens came away nearly entire. The wound healed well, but there was some subsequent iritis and a secondary operation (needling) became necessary. This was performed on June 12th, and was also followed by iritis, as a result of which the pupil became updrawn.

At her second visit, the sight of the right eye (the unoperated one) was noted as $\frac{10}{200}$; beyond the lamellar cataract there were no changes. The extracted lens was prepared for examination precisely as were those of Case 1.

The outline of the lens is irregular, some of the outermost cortical layers are wanting. The shape of the lens is, however, sufficiently well preserved to enable one to distinguish the anterior and posterior surfaces. The lamellar opacity is very distinctly visible, and looks of large size in proportion to that of the lens. The diameters of the lens as removed are 7 mm. transversely and 3 mm. antero-posteriorly; the transverse measurement of the lamellar opacity is 4·5 mm. The outline of the latter in antero-posterior section, though not quite parallel to that of the extracted lens, would probably be so if the entire lens in its capsule had been obtained for examination. There is, as in the normal lens, a greater convexity in the posterior than in the anterior layer of the opacity. This is more noticeable in sections near the periphery, and less so in those at the centre of the lens.

Microscopical Examination.—The description of the left lens of Case 1 will in the main apply to this specimen. There is the same marked difference between the nuclear and cortical parts, and the transition from the one to the other is quite abrupt. Concerning the cortical layers there is little to be said; there is splitting of the layers in several places, and ragged broken fibres at the surface, but no evident change in the fibres themselves. The nuclear part is filled by large numbers of the particles above described, which particles are generally

most numerous and smallest towards the boundary of this area, and comparatively few in number in the centre of the lens. Their average size is 0·0142 mm.

This area, as already mentioned, is of the unequally bi-convex shape of the normal lens, as is indicated in Plate B, Fig. 1, in which the anterior surface is uppermost.

Bounding this dotted area is a line which under the microscope is very like a rope, with twisted strands (*a*, Fig. 1, Plate II). This line is in no section continuous all round the nuclear part. There are numerous breaks in it, as is shown in the drawing, but at these breaks there is no irregularity in the contour of the dotted area; although there is a noticeable tendency in the layers of the lens to split along this rope-like line, it is quite clear that in good sections, such as that from which Fig. 1, Plate II, was made, the appearance is due not to separation of the layers and formation of an empty space between, but to some change in the lens fibres which gives rise to this line. A somewhat similar appearance is often seen in sections of lenses at points where the laminæ are just beginning to separate, or where a very tiny chink has formed between adjoining layers. The impression it gives is one of fine oblique striæ in the lens fibres. The width of this boundary line varies from 0·0125 mm. to 0·0375 mm. in sections near the centre where it is cut as nearly as possible at right angles to its surface; in sections near the equator of the dotted area, in which the bounding layer is cut obliquely, the width is of course rather greater than this. In the length of this line there are several small irregularities, like small knots in a rope, but, as in the rope, the continuity is not broken at these points. There is, however, an absence of the small spurs projecting from the dotted area into the cortical layers, such as were seen in some of the sections of Case 1, nor is there any indication of a double line like that in Plate I at the lower extremity of the nuclear area.

It will be seen by the foregoing description that the three lenses examined present very similar appearances. In all there is a nuclear or central area of moderate size, the outlines of which run a nearly parallel course to those of the whole lens. In the portion of lens external to this

—the cortical layers—there are no changes of any import, a few small patches of degeneration being all there visible. The line of demarcation between the cortical and nuclear areas is abrupt; there is no gradual change from one to the other. At the boundary there are indications of a thin layer, as seen in transverse section in the specimens, (*a* in the drawings) which probably extends all round, and encloses the central area. This lamina compared above to a twisted rope, does not in any of the sections form a continuous line, but exhibits numerous breaks. It seems fairly certain that it represents some definite and considerable change in the lens fibres, and probably constitutes the essential part of the "lamellar cataract." The finely dentated edges of this line suggest that it is composed of lens fibres, but its thickness exceeds that of single fibres of a healthy lens, so that the alteration in structure, whatever it be, probably involves more than one layer of fibres.

In the nuclear area in all three specimens, are large numbers of small irregular dots or particles, arranged more or less in layers which seem to run concentrically, as if following the laminæ.

Whether or no these are entirely the result of the fluids employed in preserving the lenses, in other words whether they are coagulation masses, I am unable to say positively. My impression is that they do to a large extent own this origin, but it is certainly a little remarkable that they are so accurately limited to the central area. It may be, however, that there is some diffuse change in the nuclear part of lenses with lamellar cataract, so that it is affected by hardening fluids in a different way to the cortical portion. I have never found (so far as I remember) changes exactly like these, both as regards their appearance and their arrangement, in healthy lenses, of which I have examined a great many, prepared in precisely the same way. In order to help me to arrive at a decision on this point, I prepared and cut sections of several lenses from both young and aged eyes generally healthy, but in

some instances affected by senile cataract. In two of these, one (normal) from the eye of a child æt. 3 years, and one from the eye of a man æt. 65, the former hardened in weak to strong spirit, the latter in Müller's fluid and then spirit, I found numerous small rather bright dots among the lens fibres. These, which were smaller and more regularly oval in shape, were in the first specimen scattered over the whole of the lens; in the second they were limited to the nuclear area. They were no doubt coagulation products such as Becker has described and figured in his work on the lens.

Regarding the pathology of lamellar cataract but little has been published, and in ordinary text-books of Ophthalmology nothing is said about it. Even in Becker's classical work* no description of lamellar cataract is given. Ed. Jaeger† and Von Graefe‡ were the earliest to record the examination of lenses with lamellar cataract, but no microscopic description is given. These observers found in sections of a dried lens a sharp whitish line ($\frac{1}{3}$ to $\frac{1}{2}$ mm. in thickness) separating "a normal nucleus from an unaltered cortex."

In Arch. f. Ophthal., xxxii, 2, 1886, Deutschmann gives a short account of the examination by him of a lamellar cataract from the eye of a person who committed suicide. He found the nucleus and cortex normal in appearance, but divided by a very definite zone of altered lens substance which ran concentrically round the nucleus, and consisted of altered lens fibres with numerous vacuoles and free droplets of myelin. In small chinks which were visible in this zone there was a finely granular detritus. A little more peripherally there was a second similar but incomplete zone. These zones were of varying thickness, their diameter being greatest at the poles (*see* drawing in Deutschmann's article).

* "Zur Anatomie des gesunden und kranken Linse."

† "Staar und Staar-Operationen." 1854, p. 17.

‡ A. f. Ophth., I, 2, 236.

The most recent and full description of the pathological anatomy of lamellar cataract is one by Beselin in Archiv f. Augenheilkunde, Bd. xviii, Heft 1, 1887. He had the opportunity of examining a lens extracted by Professor Schweigger from a man æt. 64, suffering from zonular cataract. The patient had had an artificial pupil made by iridectomy, and had been able to see sufficiently well till a few months before the extraction operation. His sight was then $\frac{1}{12}$ to $\frac{1}{9}$ in the left eye; the right had been lost many years previously after needling of the lens. After extraction L. V. $= \frac{1}{2}$. Beselin's description and illustrations and mine have several points in common. I had cut and examined sections of the right lens of my Case 1 before Beselin's article was published, and had made out practically all that I have now written. These notes were not published then as I knew that probably the second eye of that patient would be operated upon. As a result of this delay I was fortunate enough to obtain a third lens, and also to have the advantage of comparing my specimens with the description given by the writer just referred to.

In Beselin's specimen the area enclosed by the lamella measured in central sections 5 mm. in its transverse and 2·1 mm. in its antero-posterior diameter. The lamella consisted of a narrow zone, or rather of two incomplete zones, that on the anterior overlapping the ends of that on the posterior surface at the equator; so that there appeared to be a double layer at the margins of the lamellar opacity. These zones the author describes as chinks filled with finely granular material, containing some rounded corpuscular elements, probably fat droplets. In the greater part of its course the borders of this chink were formed by normal lens substance; its cross measurement varied from 0·016 mm. to 0·08 mm.

The nuclear area, enclosed by the zone of degeneration,

contained large numbers of small irregularly-shaped dots closely grouped and smaller at the peripheral part of this area, and larger and more scattered in the centre. These Dr. Beselin thinks are coagulation masses, the result of hardening the lens in alcohol, and thinks that if present during life greater defect of sight would have occurred. He has found similar changes in lenses with senile cataract when preserved in alcohol, but not when kept in Müller's fluid. My experience is somewhat different to his, though in the main we are agreed as to the origin of these masses. Our description and figuring of them are almost identical.

It will thus be seen that so far as our scanty knowledge on this subject will carry us, lamellar or zonular cataract (either name seems to be strictly applicable) consists essentially in a narrow zone of degenerative change in the lens fibres situated between the nuclear and cortical areas. Of the exact nature of this change, we can as yet say but little. It is possible also that the nucleus of the lens within this zone is in some way abnormal in structure. It is to be hoped and expected that future investigations will throw more light upon both these questions. That we have not already a better knowledge is due partly to the rarity with which lamellar cataracts are obtainable for microscopic examination, and partly to the fact that the crystalline lens is one of the most difficult of all tissues to manipulate for such examination. As to the cause of the occurrence of this form of cataract, whether a developmental defect, or some nutritive change in early infantile life, these microscopical investigations do not seem to assist in the determination.

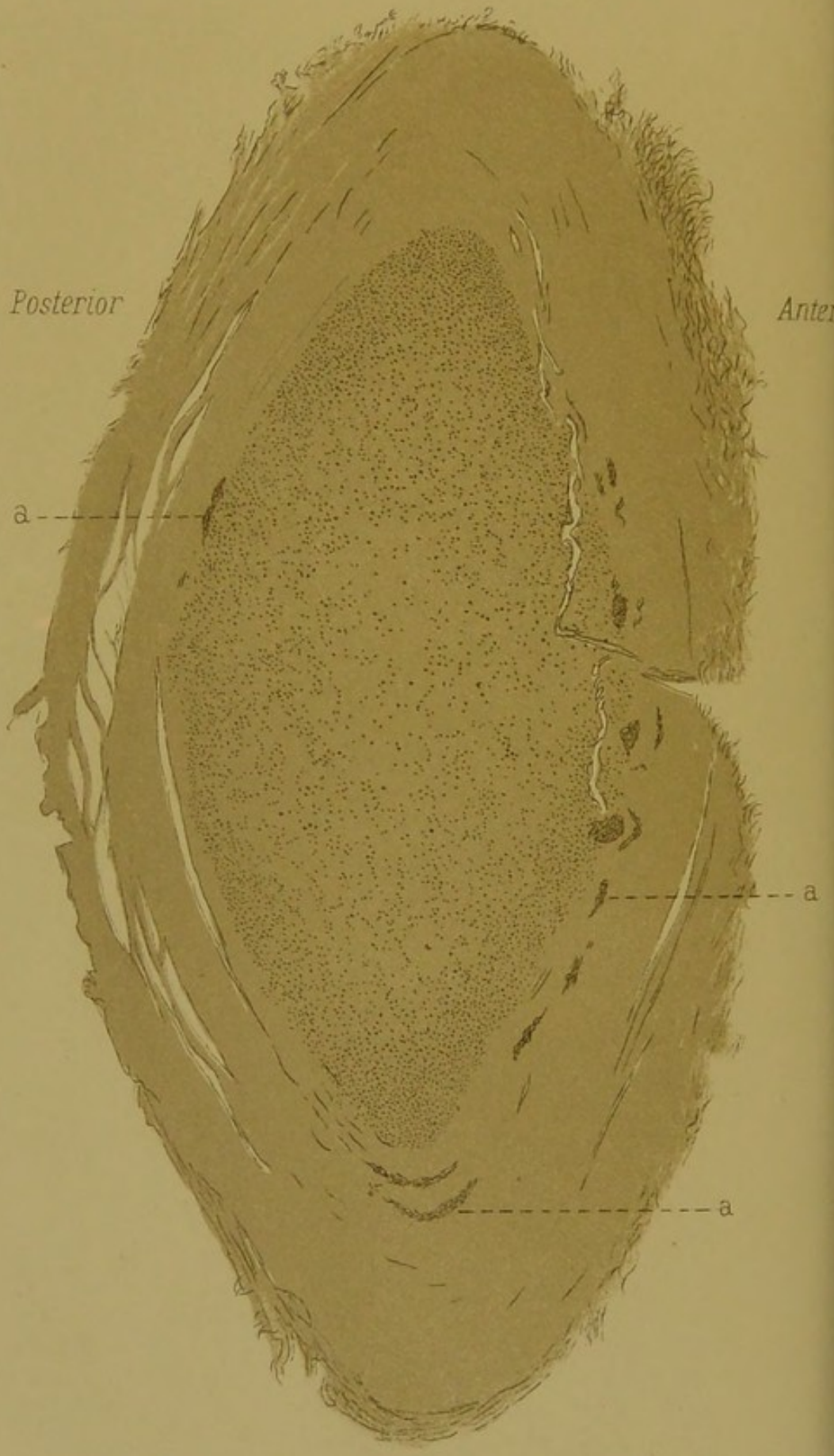

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Fig 1.

DESCRIPTION OF PLATES.

Plate I.

Drawing of a nearly central antero-posterior section of the left lens of Case 1. The outer fibres are torn and ragged, where they have separated from fibres left in the capsule. The notch in the anterior surface was cut by the cystitome. The central dotted area is shown in its entirety, and also the greater number and closer aggregation of dots near its periphery. At the points *a*, *a*, *a*, are fragments of the rope-like line separating the central and cortical parts; in places (as at the lower extremity), this appears double. On the anterior boundary line are several irregular patches of degeneration in the lens fibres. × 25.

Plate II.

Fig. 1. Drawing of part of a section of the lens of Case 2. The anterior surface is uppermost. The dotted area with its rope-like boundary is well shown, this line being here present in greater lengths than in most of the sections. It has, however, come out rather too distinctly in the print: it should be softer and less evident. × 85.

Fig. 2. Drawing of the cornea, iris, and ciliary body of the eye of Case 2, in Tuberculosis of the Eye cases (p. 152), showing the great thickening of the iris and the tubercular mass continuous with it in the cornea. Some giant-cells with surrounding reticular area are indicated in the growth. × 9.

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