Congenital anterior staphyloma / by E. Treacher Collins.

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Congenital anterior staphyloma.

By E. Treacher Collins.

(With Plates VIII, IX, and X.)

The child who is the subject of this communication was first brought to me when a month old on August 14th, 1907. The doctor who attended the mother in her confinement stated that directly after birth he noticed the cornea of the right eye was opaque and unduly prominent, also that there was a slight haze of the centre of the cornea in the left eye.

The child was born at full term. No instruments were used. The mother had not had any unnatural vaginal discharge during pregnancy, and except for a slight trace of mucus there had been no discharge from the child's eyes.

The mother was quite unable to account for the defect; she had one other healthy child, and there was no history of any congenital eye affections or other malformations in her's or her husband's families. During the third month of her pregnancy she had had a poisoned finger from a wound with a holly-bush; an abscess formed and was opened; at that time she had felt feverish and indisposed, otherwise her health had been quite good.

The appearance of the eyes when I first saw the child was said not to have altered since birth. I found the cornea of the right eye enlarged, opaque, vascular and staphylomatous. It projected forward through the palpebral aperture, but the eyelids could be closed over it. The density of the opacity varied in different parts, being greatest in the centre. As far as could be made out the iris lay in contact with the back of the cornea throughout its entire extent, there being no anterior chamber. In the left eye there was a small faint central nebula, but in other respects it appeared to be normal. I saw the child at intervals during the next fourteen months. The right cornea became gradually a little more prominent; at one time a dry horny scab formed on

its most exposed part, evidently composed of cornified epithelium. This separated, and afterwards the surface was kept moist with ointments and lotions. Up to the time of the operation the eyelids continued to close over the surface of the globe in sleep, though when the child was awake it formed a most unsightly protuberance through the palpebral fissure. The nebula of the left cornea became gradually fainter and less conspicuous.

On October 14th, 1908, when the child was fifteen months old, I performed an evisceration operation on the right eye. An elliptical piece of the front of the eye including the whole cornea was first removed; to it the iris and lens adhered. The rest of the contents of the globe, including the vitreous, choroid and retina, all of which appeared healthy, were then turned out. A glass globe was inserted into the empty sclerotic and stitched in. The child made an uninterrupted recovery from the operation.

Pathological Examination of the Elliptical Piece removed from the Front Part of the Eye.

Macroscopical appearances.—The margins of the cornea were very ill-defined; laterally it measured about 17 mm. It was opaque and had blood-vessels coursing through it. The anterior ciliary processes were included in the specimen, also the lens. The measurements of this latter after it had been hardened in formalin solution were—laterally 8 mm., anterio-posteriorly 2 mm. It was clear except at the anterior pole. When it had been separated from the back of the cornea there was seen to be a conical projection at the anterior pole, which stood out 0·8 mm. from the rest of its surface.

The posterior surface of the cornea was covered with uveal pigment except over an area corresponding to the pupil, where there appeared to be some projection backwards of the corneal substance.

On transverse section of the cornea it was seen to be much thicker than normal, and much thicker in the centre

PLATE VIII.

Illustrates Mr. E. Treacher Collins's case of Congenital Anterior Staphyloma (p. 169).

(For the micro-photographs from which the figures on this plate are reproduced the writer is indebted to Mr. E. Collier Green.)

Fig. 1 shows a Section through the centre of the Staphylomatous Cornea.

Fig. 2 shows the Epithelium on the Anterior Surface of the Staphylomatous Cornea.

Fig. 3 shows the Posterior Surface of the Cornea, with the Pigment Epithelium of the Iris in contact with it. Note complete absence of Descemet's Membrane, Ligamentum Pectinatum, and Stroma of Iris.

Fig. 2.

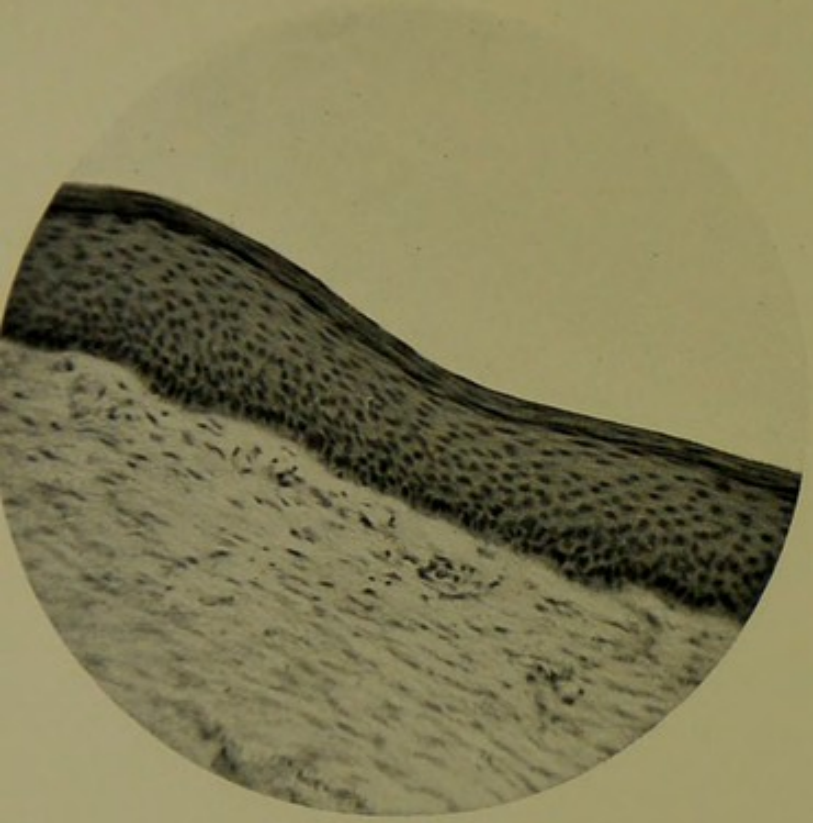

Fig. 1.

Fig. 3.

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than at the two sides (Pl. VIII, fig. 1). It measured antero-posteriorly in the centre 4·5 mm. and at the sides 2 mm.

Microscopical appearances.—The epithelium on the surface of the cornea is thicker than normal, and, except at the periphery, presents everywhere well-defined superficial horny layers devoid of nuclei. The base line of the epithelium, though showing some undulations, is everywhere very regular, there being no process of epithelial cells extending back into the fibrous tissue beneath (Pl. VIII, fig. 2).

There is no anterior limiting membrane, the epithelium resting directly on the laminated fibrous tissue composing the substance of the cornea. This latter is much thicker than normal. A little piece of the sclerotic which is shown at the margin of the cornea on each side of the sections has the normal width. Proceeding from it the cornea gradually expands in width, but more rapidly on one side than the other so that the thickest part is not quite in the centre (Pl. VIII, fig. 1).

The layers of fibrous tissue composing the cornea are not as regularly arranged as they are in the normal cornea, and have more cells distributed between them. Everywhere throughout it blood-vessels are to be seen cut in various directions. They seem to be derived partly from the ciliary vessels in the sclera and partly from those in the conjunctiva.

No trace of Descemet's membrane is to be detected, neither its elastic layer nor lining endothelium. There is no ligamentum pectinatum (Pl. VIII, fig. 3, and Pl. IX, fig. 4).

The posterior surface of the cornea is lined by the pigment epithelium of the iris, which, from the way it has become separated in places in some of the sections, seems not to have been intimately adherent to the fibrous tissue in front of it, only pressed into close contact with it.

The space corresponding to the pupillary area is not situated centrally, the pigment epithelial layers on the back of the cornea being of greater length on one side of the sections than on the other.

Over a considerable extent of the posterior surface of the

cornea nothing separates the two pigment epithelial layers from the fibrous tissue of the former. Here and there, however, in front of the anterior of the two epithelial layers and adherent to it, are collections of spindle-shaped cells; they are seen cut in some cases longitudinally and in others transversely; they resemble the cells of the unstriated muscle-tissue of the iris (Pl. X, fig. 6).

Bleached sections show the two layers of pigment epithelial cells continuous at the margin of the gap corresponding to the pupillary area, much as they are continuous at the margin of a normal pupil. The two layers of pigment cells do not lie everywhere in contact. On the side of the section where they are shortest the posterior layer is separated for a considerable space from the anterior, and is convoluted as though there was an excessive amount of it (Pl. VIII, fig. 3). On the opposite side of the sections no space is left between the two layers of pigment epithelium, but little processes are formed by projection backwards of folds in the posterior layer.

In the space corresponding to the pupillary area there is some projection backwards of the fibrous tissue composing the cornea (Pl. IX, fig. 5).

The anterior of the ciliary processes are situated abnormally far forwards, and seem to protrude from the root of the iris.

The extent of the specimen does not allow of much being made out as to the condition of the ciliary muscle. A small piece of its anterior extremity is all that is to be seen. It seems to arise from the fibrous tissue of the sclerotic, there being no ligamentum pectinatum for it to be attached to (Pl. IX, fig. 5).

A circular channel cut transversely and containing blood is seen in all the sections in the posterior part of the fibrous tissue at the sclero-corneal margin. It may correspond to Schlemm's canal or the circular arteriosus iridis major (Pl. IX, fig. 5).

Sections of the lens, which were cut separately from the rest of the specimen, show at its anterior pole a conical

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Fig. 4 shows the Corneo-sclerotic Margin. The most anterior of the Ciliary Processes is seen coming off from the Posterior Surface of the Iris. The Ciliary Muscle is arising directly from the Sclerotic, there being no Ligamentum Pectinatum.

Fig. 5 shows the Termination of the Pigment Epithelium at the Pupillary Margin on each side. The Fibrous Tissue comprising the Cornea protrudes backwards through the opening corresponding to the Pupil.

Fig. 4.

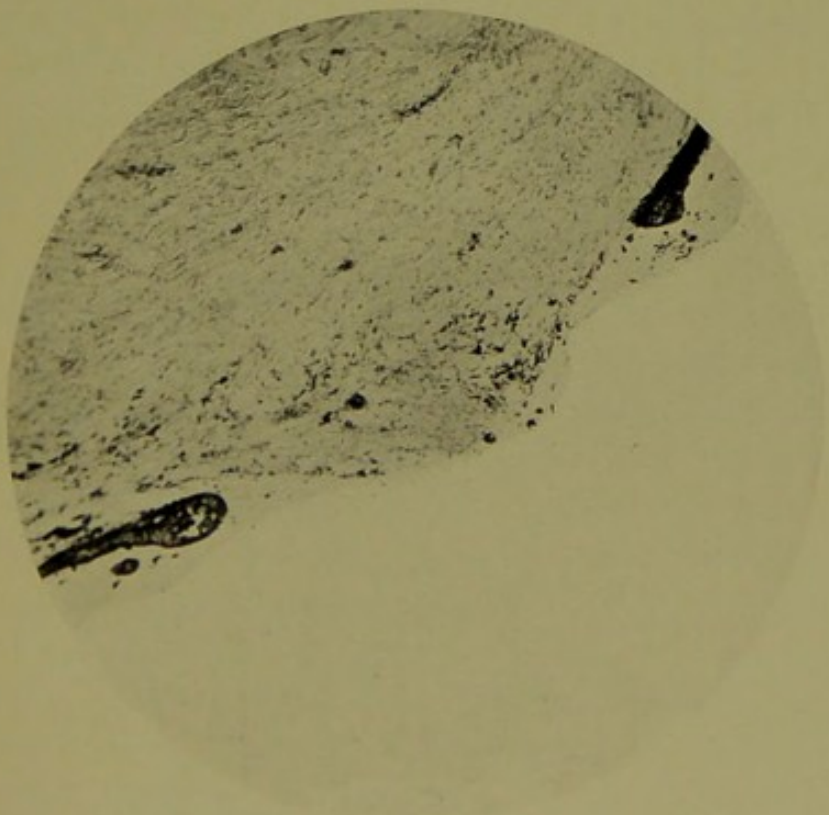

Fig. 5.

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projection produced by a bending forwards of the cortical layers in that locality (Pl. X, fig. 7). The most prominent part of this projection is covered by the hyaline capsule and a single row of epithelial cells as in the normal lens. On each side of the conical projection in the angles which it forms at its junction with the surface of the lens there are masses of tissue like those met with in capsular cataract. These masses are composed of layers of fibres with epithelial cells scattered between them; on one side there is also some calcareous material deeply staining with hæmatoxylin. The capsular cataracts are covered on the anterior surface with the hyaline capsule without any cells lining it. On the posterior surface—that towards the lens—there is a single layer of epithelial cells continuous with those lining the capsule elsewhere. So that at the margin of a laminated mass the hyaline capsule and its lining epithelium appear to part company, the former going in front and the latter behind.

The lens fibres protruding forwards into the conical projection have some deeply staining granular degenerative material amongst them.

Cells line a considerable part of the posterior capsule, there being only a small area at the posterior pole devoid of them. Immediately in contact with the cellular lining of the capsule, both posteriorly and laterally, there are numerous large globular nucleated cells or fibres.

Congenital anterior staphyloma is a rare affection, and only a few cases in which the condition has been examined pathologically have been described.

Most of those who have written on the subject have been of opinion that the changes found were the outcome of intra-uterine ulceration and perforation of the cornea. To this conclusion Parsons* and Coats,† who have recently recorded cases in this Society's *Transactions*, likewise arrived.

The microscopical appearances found in some of the

* Vol. xxiv, 1904, p. 47.

† Vol. xxvi, 1906, p. 36.

cases closely resembled those which are met with where an anterior staphyloma has resulted from a perforating ulcer of the cornea occurring in infancy. There was a central defect in Descemet's membrane, the peripheral parts remaining intact. The bulging part of the cornea was composed of irregularly arranged laminæ of vascularised fibrous tissue, resembling scar-tissue more than normal cornea, and its posterior surface was lined by the uveal pigment of the iris.

Parsons, who, besides describing a case, summarised the literature on the subject, discusses the way in which ulceration of the cornea *in utero* may be brought about. He points out that endogenous infection by bacteria through the blood-stream of an avascular structure, such as the cornea, is out of the question. Though he mentions endogenous infection by toxins entering the lymph-stream as possible, he considers exogenous infection of the cornea from the surrounding amniotic fluid as more probable.

Infants are sometimes born with ophthalmia, and in others the symptoms of ophthalmia follow so shortly after birth that it seems necessary to assume that infection took place *in utero*. Stephenson and Rosa Ford* have collected and analysed thirty-five recorded cases and added seventeen new cases of this so-called ante-partum ophthalmia. About half (44·5 per cent.) they consider satisfactorily accounted for by a premature rupture of the membranes, allowing access of micro-organisms to the baby's conjunctival sac. In the remainder (55·5 per cent.) they think "a slight injury to the membranes may determine access of micro-organisms, or infection through the uninjured membranes must be assumed to have taken place." In support of the possibility of infection occurring through the membranes, they refer to a case quoted by Armaignac, in which the *Bacillus coli communis* and other anaërobic microbes were found in liquor amnii drawn off before rupture of the membranes.

* *The Ophthalmoscope*, vol. iv, 1906, p. 214.

PLATE X.

Illustrates Mr. E. Treacher Collins's case of Congenital Anterior Staphyloma (p. 169).

(For the micro-photographs from which the figures on this plate are reproduced the writer is indebted to Mr. E. Collier Green.)

Fig. 6 shows the Posterior Surface of the Cornea and the Pigment Epithelium of the Iris; between them are some Unstriated Muscle-fibres. Note complete absence of Descemet's Membrane and Stroma of Iris.

Fig. 7 shows the Front Part of an Antero-posterior Section through the Lens. Note the Conical Projection forwards at the Anterior Pole, with a Mass of Capsular Cataract on each side of it.

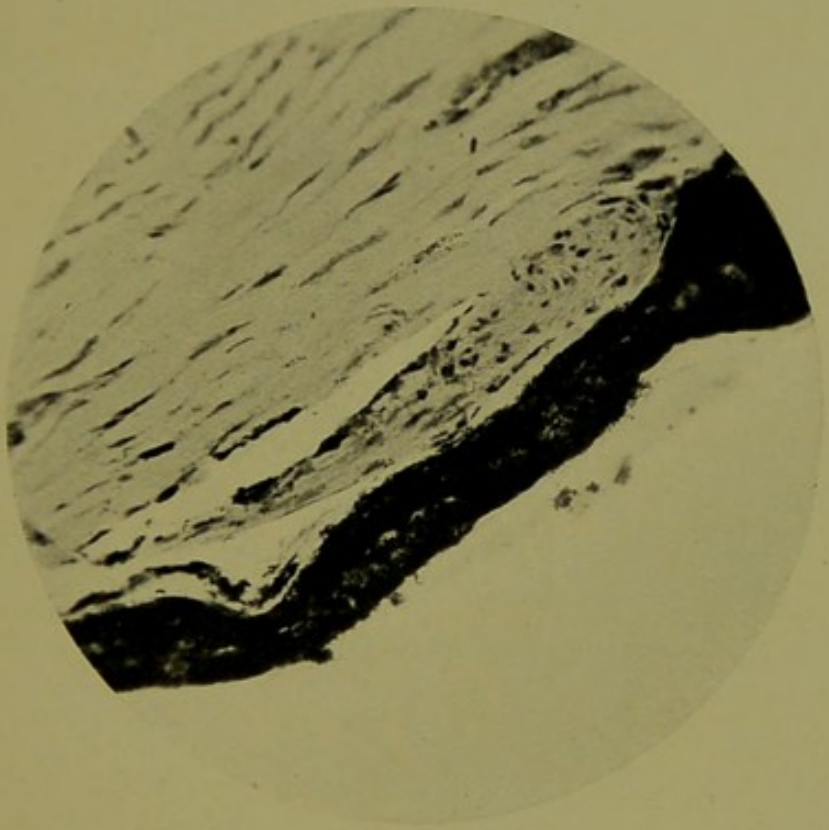

Fig. 6.

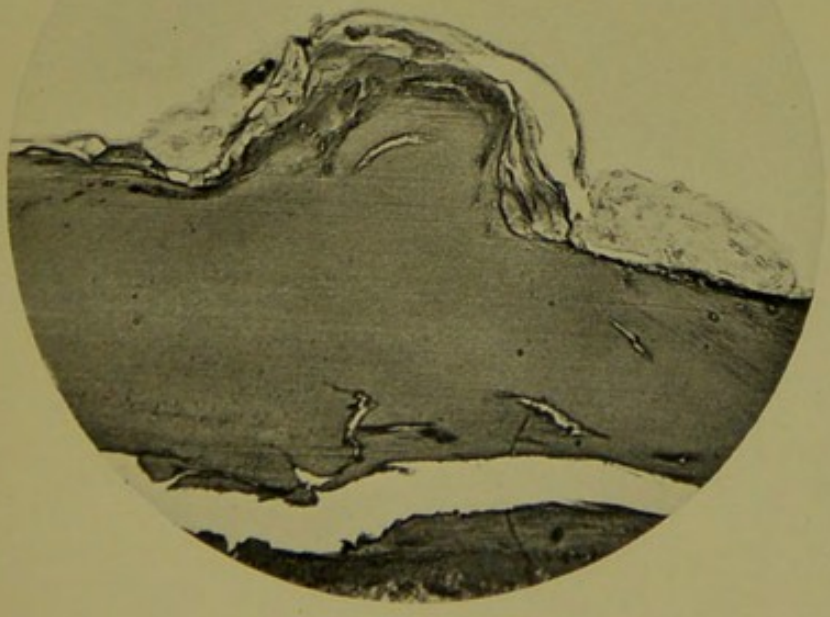

Fig. 7.

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In cases of perforating ulcer of the cornea which occur in infancy, where the resulting appearances are comparable to those met with in the recorded cases of congenital anterior staphyloma, the course of events is as follows: A large portion of the whole thickness of the cornea is destroyed by ulceration, its extreme periphery alone remaining. At the seat of the perforation inflamed iris is left exposed, from the surface of which granulation tissue grows out and fills the gap. By the conversion of this granulation tissue into fibrous tissue a new pseudo-cornea is developed; it is, of course, lined posteriorly by pigment epithelium, whilst over its anterior surface epithelium spreads from the undestroyed cornea at the sides. The usual channels of exit for the aqueous humour in such an eye being closed, it is unable to escape and the tension becomes increased. Before this increase of tension the newly-formed soft pseudo-cornea expands and becomes staphylomatous.

The above series of changes resulting in the formation of the staphyloma necessarily take some time to eventuate, usually some weeks. It seems unlikely that there would be time for them to occur *in utero*, and for the child to be born with a fully developed staphyloma from an ophthalmia due to the entrance of micro-organisms through a laceration in the membranes.

Apparently, then, we must regard congenital anterior staphyloma either as the result of ulceration of the cornea from an ophthalmia produced by amniotic fluid, infected through the intact membranes some weeks before birth, or abandon the view that it is inflammatory in origin, and find an explanation for it in some perversion of development.

Evidence as to whether a congenital defect is due to intra-uterine inflammation or to mal-development is sometimes to be found in the presence and character of other congenital defects or in the family history.

In the epitome of the recorded cases of congenital anterior staphyloma given by Parsons I do not find

mention made of any other defects apart from those of the eyes. In some there was a defect noted in the fellow eye to the one with the staphyloma. Thus its condition was described in Krückow's case as "microphthalmia"; in Hirschberg's and Birnbacher's as "phthisis bulbi"; in one of Steinheim's as "small with cystic ectasis"; in Westhoff's as "shrunken with opaque cornea"; in Lawson's and Coats's as "microphthalmic" with opacities of the cornea. In Crampton's two cases there was opacity of the cornea in the fellow eye. In the case recorded in this paper there was a nebula of the cornea of the fellow eye. In two of Steinheim's cases the anterior staphyloma was bilateral.

Parsons suggests that the comparative frequency with which the two eyes are involved favours the view that there has been exogenous infective inflammation of the eyes through the amniotic fluid.

The bilateral occurrence of developmental defects in the eyes which are certainly not inflammatory in origin is, however, of very frequent occurrence, and there is considerable evidence to show that microphthalmia is sometimes met with apart from all signs of inflammation. In none of the recorded cases has a pathological examination of the affected fellow eye been made.

In none of the recorded cases of congenital anterior staphyloma has the condition been met with in members of more than one generation. Crampton describes the affection as met with in two brothers. Steinheim gives the remarkable history of a family of five children with the following conditions: (1) Both eyes staphylomatous; (2) eyes normal; (3) right eye total staphyloma, left eye small with cystic ectasis; (4) both eyes total staphyloma; (5) both eyes white and shrunken. It is difficult to believe that in four out of five children in one family exogenous inflammation of the eyes through the amniotic fluid should occur, and in all of them result in perforating ulcers of both corneæ.

In two recorded cases the anterior staphyloma was

composed of a mass of dermoid tissue. The first of these was in a case of v. Graefe's, described by Swanzy.* A large congenital dermoid growth projected from the front of the eye, its base occupying nearly the entire cornea. It was composed of two segments, an anterior the size of a large cherry and a posterior less than half that size; they were connected by a narrow band. The colour of the growth was that of the ordinary integument, and on magnification a few fine hairs were discerned. Microscopically a cutis-like layer with hair-follicles and sudoriferous glands was found covering the growth with ordinary subcutaneous fatty tissue beneath it. A thin layer of fibrous tissue occupied the normal position of the cornea with a rudimentary iris lying in contact with it, so that there could not have been any anterior chamber. No statement is made as to the condition of Descemet's membrane. At the operation for the removal of the growth there was considerable escape of vitreous and no lens was found; it is inferred that it was congenitally absent, but as the globe itself was not excised and examined pathologically, only the staphylomatous growth, this is by no means certain.

In the other case recorded by Bernheimer† the clinical appearances were very similar. The anterior part of the staphylomatous cornea was composed of skin-like tissue. The epithelium was horny on the surface and had many down growths. There were hair-follicles, hairs and sebaceous glands. The fibrous tissue beneath contained capillaries and groups of round cells; towards the periphery, where its tissue was of a somewhat looser texture, there were masses of adipose tissue. Descemet's membrane was absent over an area in the centre. Adherent over the back of the cornea was atrophic iris with its pigment epithelium. The lens was *in situ*.

It would seem impossible to explain the presence of the dermoid tissue covering the front of the staphylomatous

* *Dublin Quarterly Journal of Medical Science*, May, 1871.

† *Arch. f. Augheilk.*, Bd. xviii, 1887, S. 171.

cornea in these two cases as the outcome of ulceration. Parsons speaks of it as a teratoid development. I think it may be accounted for by supposing an anterior staphyloma of the cornea to have occurred (as a defect of development in the way to be described later), the projection of which through the palpebral fissure prevented the union of the lids over the front of it, and the formation of the conjunctiva for a time into a closed sac. The surface of the projecting cornea would then be left exposed to the same influences as other superficial parts of the body, and like them would develop a skin-like surface.

A similar process is seen to take place when a portion of an eyelid fails to form and the surface of the eye opposite the defect remains exposed. We then have a dermoid growth on the surface of the eye associated with a coloboma of the eyelid. When no eyelids develop as in cryptophthalmos the whole surface of the eye becomes covered with skin.

The pedunculated character of a portion of the growth in Swanzy's case was probably due to its being nipped between the margins of the eyelids. A congenital dermoid of the conjunctiva which I examined microscopically became pedunculated in this way, and has been recorded by Snell.*

In cases of ulceration of the cornea occurring in infancy the destructive process never extends outward sufficiently far to destroy the whole of Descemet's membrane. It never reaches the ligamentum pectinatum. In the case recorded in this paper, therefore, where the whole of Descemet's membrane and the ligamentum pectinatum were absent, it seems impossible to explain the condition as the outcome of a perforating ulcer of the cornea, and we are forced to consider how it might have arisen as the result of some defect in development.

The substantia propria of the cornea, the hyaline layer of Descemet's membrane, its lining endothelium, and the

* *Trans. Ophth. Soc.*, 1900, vol. xx, p. 193.

anterior fibro-vascular sheath of the lens, are all products of the mesoblastic tissue which grows in from the sides in front of the lens vesicle to separate it from the surface epiblast.

At one time this mesoblastic tissue is entirely composed of cells of a uniform type. Then it becomes differentiated into two parts, an anterior which thickens quickly and where the cells show a tendency to become elongated, and a posterior in which the cells are round and arranged in two rows. Very soon these two parts become separated by a thin hyaline membrane, which gradually thickens and forms the hyaline layer of Descemet's membrane. It is probably produced as a kind of secretion from the row of cells on its posterior surface which develop into its lining endothelium. The part of the mesoblast in front of the hyaline layer remains devoid of blood vessels and is gradually transformed into the laminated fibrous tissue of the substantia propria. In the posterior of the two layers of rounded cells behind the hyaline membrane blood-vessels extend from the anterior ciliary arteries, it becoming the anterior fibro-vascular sheath of the lens.

The abnormality in the specimen which is here described can, I suggest, be adequately explained as due to a failure of the mesoblast which intrudes between the lens vesicle and the surface epiblast to become differentiated into its several layers, *i.e.*, an atypical development of this mesoblast. No differentiation of it into two parts took place and no hyaline layer formed. There was, therefore, no Descemet's membrane and no fibro-vascular sheath, only a thick mass of fibrous tissue. Blood-vessels, instead of being restricted to its hindermost part, the fibro-vascular sheath, permeated in various directions, and so tended to alter its appearances considerably from that of the normal substantia propria.

The anterior fibro-vascular sheath plays a very important part in the development of both the iris and the lens. The anterior layers of the iris and stroma are mainly produced from it. Beneath it the two layers of

the secondary optic vesicle, which become the posterior pigment epithelial layers of the iris, extend inwards, and from them, according to the researches of Forsmark * and others, the muscular tissue of the iris is developed.

The lens, during the most active period of its growth in fœtal life, before the formation of the anterior chamber and the secretion of the aqueous humour, receives a large part of its nutrient supply from the anterior fibro-vascular sheath.

If, then, as I have suggested in the case here recorded, the anterior fibro-vascular sheath failed to become differentiated off from the mesoblastic tissue which intrudes between the lens and the surface epithelium, we should expect to find defective development of the stroma of the iris and of the lens. What we do find is that the pigment epithelial layers of the iris are lying in contact with the vascularised fibrous tissue which represents the cornea, but that nowhere can any tissue corresponding to iris stroma be recognised in front of them. Here and there patches of spindle-shaped cells similar to those of the unstriated muscular tissue of the iris are to be seen in front of the pigment epithelium, but no stroma. The pupillary area is clearly distinguishable.

The lens is small, much flatter than usual from before backwards, and besides other abnormal appearances in the arrangement of its cells and fibres, presents a most peculiar condition at the anterior pole. There is a conical projection forwards of the lens fibres, which apparently is encircled by a ring of capsular cataract having the usual characteristics of capsular cataracts at the anterior pole of the lens.

Coats, in the pathological examination of an eye with congenital anterior staphyloma, recorded by him and Arnold Lawson, describes a forward dislocation of the inner layers of the anterior part of the uvea. The ciliary processes arose further forward than the ending of the

* *The Muscular Tissue of the Human Iris: its Structure and Development*, Jena, 1905. Reviewed in *Ophthalmic Review*, vol. xxiv, 1905, p. 134.

membrane of Descemet; the pars plana was on a level with the ligamentum pectinatum, and the ora serrata was in front of the ciliary muscle.

Such a condition, he points out, is one of extreme rarity; he could only find one other recorded instance of it: that was in a case of congenital anterior staphyloma described by Krückow in 1875.

It is very probable that in the specimen the subject of this paper a somewhat similar condition was present; its extent, however, did not permit of a complete examination of the relations of the ciliary body. All that can be said is that the ciliary processes were abnormally far forwards, the most anterior projecting out from the back of the root of the iris.

From the pathological point of view I regret I did not remove the whole eye instead of eviscerating and inserting a Mules' globe. From the clinical point of view, however, I have achieved a more satisfactory result by the evisceration than would have been produced by enucleation.

Coats naturally infers that some connection must exist between congenital anterior staphyloma and dislocation of the uvea, and is led to ask how it is that the latter is not also met with in connection with post-natal anterior staphyloma, which is of much commoner occurrence.

Coats, who believes the pre-natal, like post-natal anterior staphyloma, is the outcome of perforating ulcer of the cornea, suggests that the difference is due to the looser connection between the uvea and the structures external to it (including the ciliary muscle) during fœtal life, so that when stretched it is capable of being displaced bodily forwards. On the other hand, after birth, the connection having become more intimate, the stretching is only capable of causing elongation and atrophy.

I would suggest that this difference in the arrangement of the anterior part of the uvea in cases of pre-natal and post-natal anterior staphyloma may be taken as evidence in favour of a different origin of the staphyloma in the two classes of cases. In the pre-natal anterior staphyloma

there would be a natural tendency for the anterior part of the secondary optic vesicle to extend forwards over the inner surface of the expanded anterior part of the globe, so leading to a forward displacement of the ciliary processes, *pars plana* and *ora serrata*. In the post-natal anterior staphyloma, the uveal, having first developed in the normal way, would subsequently have acquired adhesion to the cornea, the bulging of which would cause parts of it to become stretched and atrophied.

In conclusion I wish to summarise briefly the different malformations which may arise from aberrations in development of the mesoblast, which intrudes between the surface epithelium and the lens vesicle, examples of which I have been able to record from time to time in the *Transactions* of this Society or elsewhere.

(*a*) Complete failure in the formation of Descemet's membrane, the ligamentum pectinatum, and the anterior fibro-vascular sheath, resulting, as in the case here described, in a vascularised thickened cornea, absence of stroma of iris, apposition of its pigment epithelium to the posterior surface of the cornea, absence of anterior chamber, increase of tension, and anterior staphyloma.

(*b*) Complete failure in the formation of Descemet's membrane, with adhesion of the anterior capsule of the lens to the fibrous tissue of the cornea, resulting in obstruction to the growth inwards of the iris between them, and microphthalmia.

This condition was met with in a chick's eye described by Parsons and myself in vol. xxii of our *Transactions*; there was a congenital absence of the eye on the other side (anophthalmia).

(*c*) Failure in development of a large central area of Descemet's membrane, resulting in an extensive anterior synechia of the iris, absence of anterior chamber, increase of tension, anterior staphyloma, and often extreme thinning of part of the cornea.

In some of these cases, in which the staphylomatous condition occurred early and prevented the union of the

eyelids over the front of the eye for a portion of fœtal life, the protuberant part has developed a skin-like covering, as in the cases recorded by Swanzy and Bernheimer.

(*d*) Failure in development of a small piece of Descemet's membrane, with an adhesion of the iris or persistent pupillary membrane to the *substantia propria* of the cornea. The cornea in all other respects normal, and the extent of the adhesion not sufficient to give rise to increase of tension.

An example of this condition is recorded by von Hippel,* and I have described it as present in the eye of a cat.†

(*e*) A complete development of the hyaline layer of Descemet's membrane, but a failure over a small area of the cells lining it to become differentiated and separated from the anterior fibro-vascular sheath, resulting in an anterior synechia of the iris or pupillary membrane, the cornea in all other respects being normal. I have described this condition as being present in an eye with a persistent and patent central hyaloid artery.‡

A case presenting similar appearances has also been recorded by Ballantyne.§

(*f*) A normal development of Descemet's membrane but a complete failure in the formation of the ligamentum pectinatum. There being no channels for the exit of aqueous humour, increase of tension and buphthalmos result.

I have described this condition as present in a buphthalmic eye removed from a boy, æt. 14 years.‖ Descemet's membrane, instead of splitting up into a number of fibres at the angle of the anterior chamber, continued round it, extending for a short distance along the anterior surface

* *Arch. f. Ophth.*, Bd. lx, Heft 3, S. 444.

† *Trans. Ophth. Soc.*, vol. xxvii, 1907, p. 203.

‡ *Lancet*, vol. ii, 1894, and *Researches into Anat. and Path. of Eye*, 1896.

§ *Trans. Ophth. Soc.*, vol. xxv, 1905, p. 319.

‖ Erasmus Wilson Lecture, *Lancet*, vol. i, 1900.

of the iris and terminating rather abruptly. Externally to the angle of the chamber in this eye there was a broad adhesion of the root of the iris to the sclerotic, to which also the ciliary muscle was attached, but neither fibres of the ligamentum pectinatum nor a canal of Schlemm could be detected.

I have also met with complete congenital absence of the ligamentum pectinatum in two buphthalmic eyes which occurred in connection with plexiform neuroma of the eyelids. One is described in a paper on that subject by Snell in vol. xxiii of our *Transactions*, and the other in a paper by Rayner Batten and myself in vol. xxv.

(*g*) A normal development of the Descemet's membrane and the ligamentum pectinatum, but an imperfect separation from the back of the latter of the peripheral part of the anterior fibro-vascular sheath, which becomes the anterior layers of the iris. The angle of the anterior chamber is then imperfectly prolonged outwards and a condition exists which is normally present in some of the lower animals, *i.e.*, a ligamentum pectinatum with an outer laminated zone and an inner cavernous zone. The latter should disappear before birth, leaving only the former. I have met with a persistent cavernous zone in several microphthalmic eyes without any increase of tension.* I have also met with it in congenitally buphthalmic eyes in which presumably its presence offered an impediment to the exit of fluid from the eye, and so was the cause of the increase of tension and enlargement of the globe. (*March 11th*, 1909.)

* *Trans. of the IXth Internat. Ophthal. Congress*, 1899, p. 88.

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