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Contributors

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DISCUSSION ON POST-OPERATIVE COMPLICATIONS OF CATARACT EXTRACTIONS.

Opening Paper.

By E. Treacher Collins.

(With Plates VII to XI.)

In opening this discussion on the complications which occur after extraction of cataract I propose to deal with the subject mainly from a pathological standpoint. In order to show how derangements in the healing process occur in the various structures involved, it will be necessary to recapitulate briefly what we know concerning the uncomplicated healing of wounds in each of these structures.

The Difference in the Uncomplicated Healing of Incisions in the Cornea and of Incisions at the Limbus with a Conjunctival Flap.

After an incision through the cornea the retraction of the divided tissue is most marked at its anterior and posterior surfaces, so that when the lips of the wound come together again there is contact of the central layers of the substantia propria and wedge-shaped gaping spaces left anteriorly and posteriorly.

Through the gap in Descemet's membrane the aqueous humour permeates, causing swelling of the lips of the incision. The newly formed aqueous is more albuminous than the normal contents of the anterior chamber. From this albuminous aqueous or from serous exudate from the corneal tissue, a fibrinous coagulum is formed, which agglutinates the edges of the wound and serves as a

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matrix for the subsequent development of cicatricial tissue.

The wedge-shaped gap anteriorly soon becomes filled with a plug of epithelium, which extends into it from the two sides.

The wedge-shaped gap posteriorly becomes filled with the fibrinous coagulum, over the posterior surface of which the divided endothelium of Descemet's membrane gradually extends. When this is again intact any further filtration of aqueous humour into the wound ceases.

The cells of the cicatricial tissue which replace the fibrinous coagulum are derived from the corneal corpuscles. As it develops it extends upwards into the anterior wedge-shaped area, thereby gradually reducing the thickness of the plug of epithelium by which it first became filled to that of the normal covering layer. The cicatricial tissue also extends downwards into the posterior wedge-shaped area, entirely filling it right down to the endothelium. In course of years a new layer of hyaline tissue, similar to that of Descemet's membrane, may become formed from the endothelial cells bridging across the gap in the divided structure.

After an incision through the limbus with a conjunctival flap there is retraction of the anterior and posterior layers of the sclero-corneal tissue, and the formation of wedge-shaped spaces just as after an incision through the cornea. The anterior wedge-shaped area does not, however, become filled with epithelium. In consequence of the conjunctival flap, the opening in the epithelium does not correspond in position with the opening in the fibrous tissue. What extends down into the wedge-shaped area anteriorly is the sub-epithelial vascular tissue of the conjunctiva.

The time which it takes the epithelium to re-form over an incision through the cornea or conjunctiva has been investigated histologically, and can also be studied clinically by the use of fluorescein stain.

In corneal wounds the anterior wedge-shaped area has

been found filled after twenty-four hours. The epithelial cells of the cornea are said to be normally in a state of tension; directly this is relaxed there is a tendency to movement of them inwards. Mitosis commences in them, after division, within an hour (Weinstein).

The healing of wounds in the ocular conjunctiva of rabbits has been studied histologically by Mayou.* After a wound of the ocular conjunctiva the opening, which has to be re-covered by epithelium, is wider than that left after an incision through the cornea, owing to the wider retraction of the edges of the former. The surface over which the epithelium has to spread is also more irregular. Masses of fibrin are encountered, above or below which it has to make its way, so that papilla-like processes become formed. Mayou found the epithelium over an experimental conjunctival wound imperfect at the end of forty-eight hours and complete at the end of 120 hours.

In seven cases of extraction of cataract I have employed fluorescein, at varying periods after the operation, to see when the edges of the conjunctival flap cease to stain. I found staining in one case completely absent on the sixth day; on the other hand I have found staining present as late as the eighteenth day. It is a method of investigation worthy of more extended and careful observation.

Grooving of the Surface of the Wound.

Unusually wide separation of the margins of the anterior wedge-shaped area of a corneal incision causes delay in the formation of the plug of epithelial cells which tends to make the surface level. The epithelium at the margins of the wound grows down round its sides to the apex of the triangle, but does not become of sufficient thickness to meet across the gap. The result is the production of a groove in the surface along the line of the incision.

I used frequently to see such a groove in eyes operated

* *The Changes produced by Inflammation in the Conjunctiva.* Lecture II, 1905.

upon by a surgeon at Moorfields, who made a practice of turning the blade of the Graefe's knife forwards in cutting out; so that at the conclusion of his section it was at right-angles to the surface of the cornea. It is not as a rule met with after sections made with a keratome, which pass more obliquely through the layers of the cornea than those made with a Graefe's knife.

In my own operations I have had to cut out sooner and more at right-angles than I intended to, so that grooving of the surface has resulted, under the following circumstances:

(*a*) When the patient has made an unexpected movement upwards of the eye;

(*b*) When the aqueous humour has escaped beneath the conjunctiva at the counter puncture, ballooning it out;

(*c*) When the iris has prolapsed in front of the knife.

Epithelial Downgrowths and Cysts of the Anterior Chamber and Cornea.

Should the lips of a corneal extraction incision fail to become agglutinated by the temporary coagulum, or having become agglutinated, should they subsequently become reopened, there is a tendency for the surface epithelium to extend inwards more deeply than usual. It may even extend through the whole length of the incision and pass into the anterior chamber. In some cases the whole of the anterior chamber has become lined by epithelium proceeding down from the surface in this way. It will spread over the posterior surface of Descemet's membrane, over the anterior surface of the lens capsule and iris. In such cases increase of tension develops.

I was, I believe, the first to demonstrate the presence of an epithelial lining in the anterior chamber of eyes operated on for extraction of cataract. In 1892 I showed at this Society sections from two eyes in which this condition was present. In none of them had I found any

connection between the surface epithelium and that in the anterior chamber. I described the condition as an implantation cyst, thinking that a detached piece of the surface epithelium must have been carried into the anterior chamber at the time of the operation, and have spread round it.

Meller and Fuchs* showed in 1901 that a condition, similar to that which I had described, could be produced by an extension downwards along the corneal wound of the surface epithelium. I think it is probable that had I examined serial sections of the corneal cicatrices in my cases, I should have found in some of them a similar connection between the epithelium in the eye and that on the surface.

A diagnosis of the existence of an epithelial cyst in the anterior chamber can sometimes be made clinically. I have seen several eyes in which I have suspected its presence, and in one case I was able to confirm the correctness of my diagnosis by subsequent pathological examination (Pl. VII, fig. 1).

The increased tension to which the cyst gives rise does not make its appearance until some months after the operation ; there may be for a time good vision, so that the operation appears to have been a success. Then slowly the glaucoma manifests itself with superficial œdema and haze of the cornea. The anterior chamber will in one part appear exceedingly shallow, where the iris is pressed forwards by fluid unable to pass into it, and in another part, where the cyst is situated, very deep.

The epithelium extending down from the surface into an extraction wound may sometimes form a cyst in the corneal cicatrix. In 1890† I described the sections of a shrunken eye after cataract extraction, in which I found an epithelial-lined cyst in the corneal tissue, evidently in the track of the cicatrix and probably produced in this

* *Archiv. f. Ophth.*, Bd. li, Ab. 3.

† *Roy. Lond. Ophth. Hosp. Rep.*, vol. xiii, 1890, p. 44.

PLATE VII.

Illustrates Mr. E. Treacher Collins's paper on Post-operative Complications of Cataract Extractions (p. 18).

[The figures illustrating this paper are from photomicrographs taken by Mr. E. Collier Green.]

Fig. 1.—Shows an extension down of the surface epithelium along the lips of an extraction wound. It passed into, and completely lined the anterior chamber. The condition resulted in glaucoma, which necessitated the removal of the eye.

Fig. 2.—Shows a section through a limbal cicatrix with a conjunctival flap in an eye removed nine months after extraction of cataract. The surface epithelium is seen extending down into the subconjunctival tissue, but ceases at the surface of the sclera.

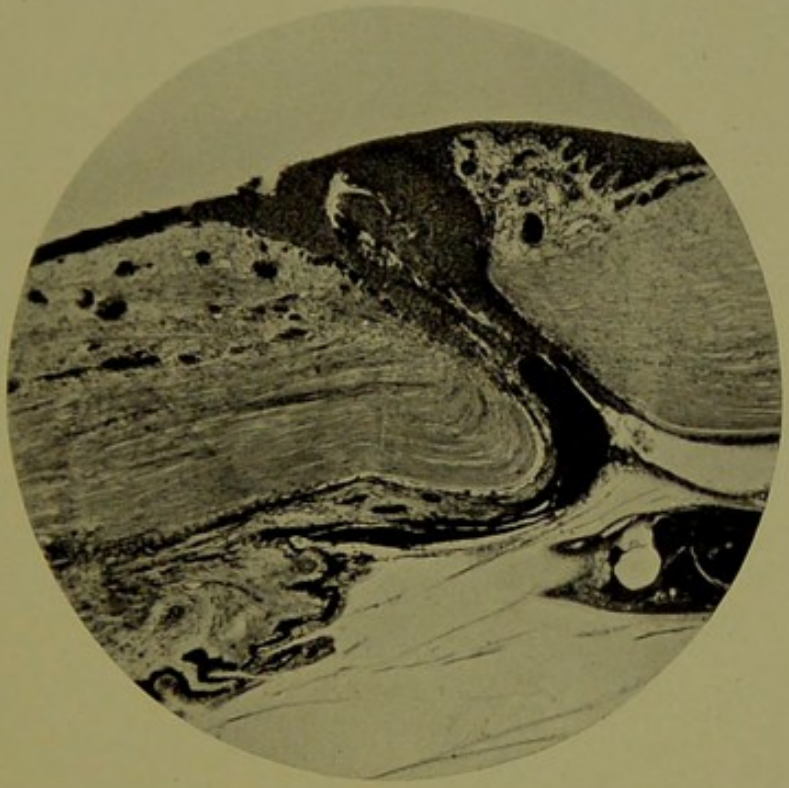

Fig. 1.

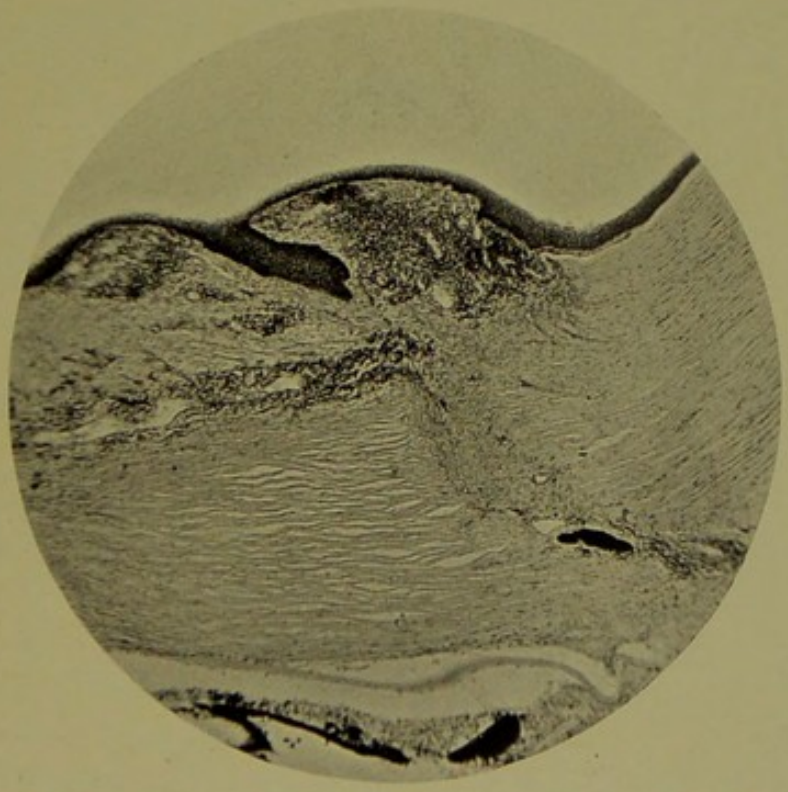

Fig. 2.

Adlard & Son, Impr.

way. Thomson Henderson* has described an epithelial cyst in a corneal cicatrix after cataract extraction, which he says was no doubt the cause of the astigmatism that had been noted in the eye previous to its removal.

The most effectual way to avoid an extension downwards of epithelium into the eye is to make an oblique incision and a conjunctival flap. I have a section of an eye in which a conjunctival flap was made, and in which an extension down of the epithelium occurred as far as the entrance of the opening in the fibrous tissue of the sclera, where it ceased (Pl. VII, fig. 2). I have sections also of an eye where re-opening of a wound occurred, and where the conjunctival flap became folded in round the inner lip of the wound. It demonstrates the importance of seeing that a conjunctival flap lies nicely smoothed out at the conclusion of an operation.

Downgrowth of Conjunctival Blood-vessels between the Lips of a Wound.

If there is delayed agglutination of a wound at the limbus when a conjunctival flap has been formed, what extends down between its two sides is not epithelium, but the sub-epithelial vascular tissue of the conjunctiva. I have a specimen showing conjunctival blood-vessels extending down through the whole length of a wound and vascularising a fibrous membrane of inflammatory origin which fills the coloboma (Pl. VIII, fig. 3).

When a piece of iris has become entangled between the posterior lips of an extraction incision, conjunctival blood-vessels extending down from the surface may become connected with those of the iris and inflammation arising in one structure may easily spread to the other. In another specimen I have found epithelium together with subepithelial vascular tissue extending down between the lips of an extraction incision on its distal or scleral side (Pl. VIII, fig. 4).

* *Ophth. Review*, vol. xxvi, 1907, p. 140

Delayed Union of the Posterior Surface of an Extraction Incision; Haze of Cornea in Vicinity of Incision; Striated Opacity of the Cornea.

Delay in the closure of the posterior surface of an extraction incision may be the result of the interposition of a portion of the intra-ocular contents (iris, lens capsule or vitreous) between the cut ends of Descemet's membrane.

The longer the lips of the incision posteriorly are kept apart, and the endothelium prevented from bridging across the gap, the greater the amount of filtration of aqueous humour into the substantia propria. Such filtration causes distension of the lymph-spaces, swelling of the tissue, and opacity.

The commonest form of opacity of the cornea met with after extraction of cataract presents a striated appearance. It is often incorrectly spoken of as "striated keratitis"; it is not an inflammatory affection. The striations extend downwards from the corneal margin of the incision, tapering off towards their lower extremities. They are sometimes crossed by horizontal streaks lying more superficially.

Two views have been put forward to explain the nature of these striations. Becker and Recklinghausen attribute them to widening of the lymph-spaces in the cornea. Hess and Schirmer consider them to be due to folding of the posterior layers of the cornea, including Descemet's membrane, the result of alteration of tension in Descemet's membrane consequent upon the section. In every case after extraction of cataract the tension of Descemet's membrane is altered, and yet it is only in a small percentage of the cases that striated opacity of the cornea occurs. Out of 518 of my own cases I find striated opacity of the cornea recorded in 82 or 15·8 per cent. It would seem, therefore, that there must be some other factor in its formation besides relaxation of tension.

Several observers have noted that the condition is most frequently met with when there has been some difficulty

PLATE VIII.

Illustrates Mr. E. Treacher Collins's paper on Post-operative Complications of Cataract Extractions (p. 18).

Fig. 3.—Shows a section through a limbal cicatrix in an eye removed three months after extraction of cataract. Exudative irido-cyclitis had resulted in the formation of a dense grey membrane which filled the coloboma. This membrane was vascularised from above by blood-vessels extending from the subconjunctival tissue down along the whole length of the cicatrix. One of these vessels is shown passing through the cicatrix in the figure.

Fig. 4.—Shows a section through a limbal cicatrix in an eye removed one month after extraction of cataract. The wound was reopened on the fifth day in order that the anterior chamber might be irrigated out with peroxide of hydrogen solution, exudative iritis having supervened. The surface epithelium and some subepithelial vascular tissue is shown extending down between the lips of the incision on its scleral side.

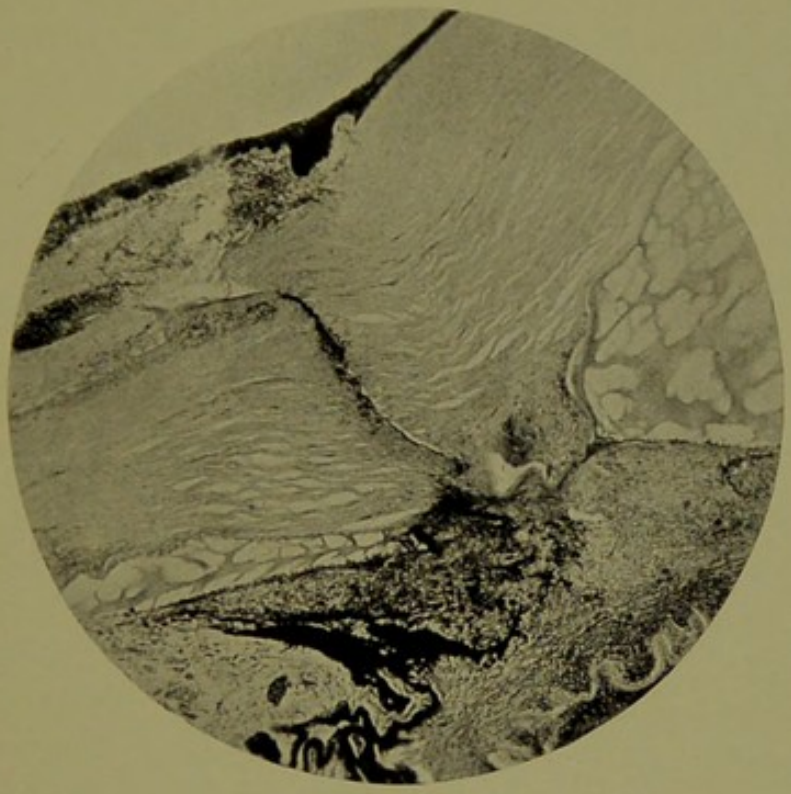

Fig. 3.

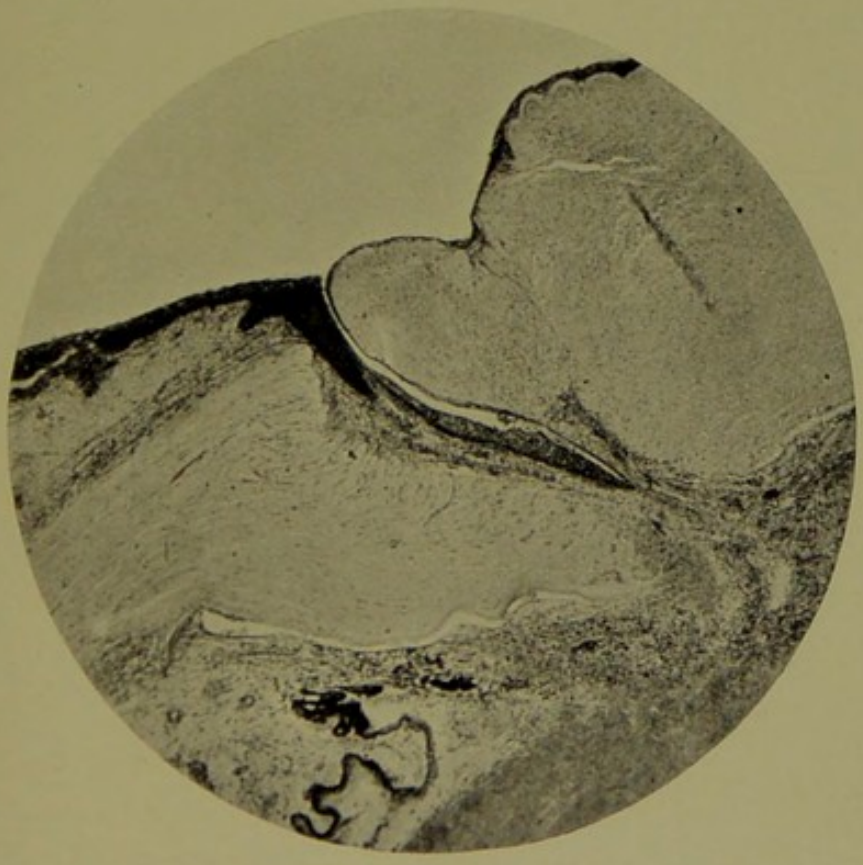

Fig. 4.

Adlard & Son, Imp.

in the presentation of the lens, and where presumably there may have been more than the usual amount of disturbance in the endothelium bordering the lips of the incision.

I used to note its presence frequently after iridectomy by a surgeon who made a practice of having a drop of 1 in 20 solution of carbolic acid on the blade of his keratome at the time of the incision. So strong a solution of carbolic must have damaged the delicate endothelium of Descemet's membrane.

The densest opacity of the cornea following cataract extraction which I have seen was in five cases in which a surgeon, immediately after removal of the lens, introduced into the anterior chamber some 1 in 25,000 solution of the biniodide of mercury. In some of these cases the opacity was a uniform white haze extending down from the region of the incision, and in others a striated opacity. It remained permanent and later became accompanied by a dulness of the surface. The cause of the opacity in these cases was probably the destruction of the endothelial cells lining Descemet's membrane by the biniodide solution, which allowed the aqueous humour to filter into the substance of the cornea. I suggest that the slighter cases of striated opacity, which after a time disappears, are also due to filtration of the aqueous humour into the substantia propria, this filtration being the chief cause of the rucking of Descemet's membrane, which Hess's and Schirmer's experiments seem to show give rise to the vertical streaks. As the endothelium re-forms the filtration ceases and the opacities disappear. The horizontal and more superficial streaks are probably the result of distended lymph-spaces with the imbibed aqueous.

Prolapse of the Iris; Cystoid and Bulging Scars.

The prolapse of a fold of iris into the incision after an extraction of cataract prevents its two edges coming together and re-uniting. The resulting condition is either

a cystoid or bulging scar, according to the depth to which the prolapse has extended. If it passes right through to the conjunctival flap, that structure becomes adherent to it, and the anterior surface of the iris unites to the sclero-corneal tissue on each side of the incision. A permanent gap is thus established in the fibrous tissue of the globe, which, being a weak spot, tends to bulge when the intra-ocular pressure is re-established. As the gap bulges the iris tissue lining it atrophies, breaks take place in the continuity of the pigment epithelium, and the translucent structure which v. Graefe termed a "cystoid cicatrix" is produced.

If the prolapse of iris does not pass forwards through the whole thickness of the sclero-corneal tissue, then it is only the posterior layers which are prevented from uniting. Anteriorly healing of the wound takes place in the usual way, but a permanent gap lined by iris tissue is established posteriorly. Such a scar like that previously described forms a weak spot in the globe and is liable to bulge. Owing, however, to the presence of fibrous tissue uniting the anterior layers, it does not stretch sufficiently to become translucent, so does not resemble a "cystoid scar."

The chief danger of a cystoid cicatrix is the liability of an eye in which it is present to become affected with suppurative inflammation of the uveal tract months or years after the healing of the wound. Wagenmann* has recorded the results of the microscopical examination of eleven eyeballs affected in that way. In all micrococci were found in the interior of the eye; the suppurative process appeared in all the cases to have started from the cicatrix, with which the vitreous was usually found in contact. Wagenmann regarded the condition as one of new infection through the cicatrix, and not due to micrococci having entered the wound before it was healed and then for a long time remaining inert; or as due to

* *Archiv. f. Ophth.*, Bd. xxv, 1889, Ab. 4, S. 116.

organisms brought to the wound by the circulation, and there finding a congenial soil.

Astigmatism.

After extraction of cataract in the large majority of cases a certain amount of astigmatism is produced. The curvature of the cornea at right angles to the wound becomes diminished, and that parallel to it increased. The amount of the astigmatism is, as a rule, greatest in those cases where some inclusion of iris has occurred between the lips of the wound. In a recent, quite uncomplicated case, however, I found a difference of eight dioptres between the two meridians which remained permanent. In most cases the amount tends to diminish as cicatrisation proceeds. Should, however, there be some weakness in the cicatrix, as from a prolapse of a fold of iris, or should there be increase of tension, bulging may take place at the seat of the wound, causing the astigmatism to increase. In one case, where increase of tension came on after extraction, I found eleven dioptres difference between the two meridians; with a plus cylinder of that strength and a + 6 sphere the patient's vision was equal to $\frac{6}{18}$.

Thomson Henderson,* who has paid special attention to the causation of post-operative astigmatism, gives the following explanation of its occurrence:

"After extraction there is great tendency for the central or corneal flap to spring forward and overlap the scleral margin. In this is to be found the primary cause of the subsequent astigmatism. The predisposing cause is to be found in the position of the incision, *i. e.* whether corneal or limbal. In the former position of the wound the resulting gap between the two cut surfaces is finally reduced to a minimum, so that the normal radius of curvature of the cornea is restored. In the latter the interspace is filled by connective-tissue downgrowth which

* *Ophth. Review*, vol. xxvi, 1907, p. 138.

prevents complete apposition of the cut surfaces. In the subsequent cicatrisation this interspace is diminished, but still the effect is that of a wedge introduced into the segment of a circle, resulting in an increase of the radius of the latter—otherwise a diminution of curvature in the vertical meridians."

It would be interesting to know from clinical observation if limbal incisions result more frequently in astigmatism, or produce higher degrees of astigmatism, than corneal incisions in accordance with Thomson Henderson's views. My own cases do not afford sufficient evidence in the matter, as I always aim at making a limbal incision.

Suppurative Inflammation Starting in the Cornea.

Suppurative inflammation starting in the cornea is, with the exception of expulsive hæmorrhage, the most rapidly destructive complication met with after extraction of cataract. Through the gap made in the epithelium by the incision pyogenic germs gain entrance to the fibrous tissue of the cornea and there find a suitable soil in which to proliferate. The pneumococcus is by far the most frequent pyogenic organism met with in these cases. The other organisms to which the condition has been attributed are: *Staphylococcus pyogenes aureus*, ozæna bacillus, bacilli of the diphtheria group, and streptococci.

In fifty cases, the notes of which I collected* from the case-books of the Moorfields Hospital, I found that the suppuration commenced in the large majority on the first, second, or third day; in eight of them it did not appear until on or after the fifth day; and in one not until the thirteenth day.

When the epithelium has re-formed over the wound the risk of infection by the above-mentioned pyogenic organisms ceases, because they are incapable of penetrating intact epithelium. As corneal incisions are more quickly covered over by epithelium than those at the

* *Roy. Lond. Ophth. Hosp. Rep.*, vol. xii, 1888, p. 19.

limbus with a conjunctival flap, it might be thought that they were less likely to be implicated by this form of inflammation. This advantage seems, however, to be more than counterbalanced by the vascular conjunctiva offering a greater resistance to pyogenic organisms than the avascular cornea.

It is interesting to compare the number of suppurations after extraction of cataract which occurred at Moorfields in former times with those of more recent years :

Morton* recorded in 1875–6 146 cases, with 8 suppurations—5·47 per cent.; in 1883 there were 225 cases, with 14 suppurations—6·2 per cent.; Marshall† recorded in 1889 to 1893 1519 cases with 26 suppurations—1·7 per cent.; my own operations from 1900 to 1912, 518 cases, with 6 suppurations—1·15 per cent.

It will be well to enumerate the chief alterations in practice with which this diminution in the percentage of suppurations has coincided, because they indicate the direction in which more strenuous efforts should be made to reduce it still further :

(*a*) Greater precautions in trying to eliminate all infective discharge from the lacrimal sac, conjunctiva, and lid margins.

(*b*) Sterilisation of instruments. No sterilisation of instruments was employed until after 1883.

(*c*) The introduction of local anæsthesia. Cocaine was first employed in 1884. When a general anæsthetic was administered portions of the intraocular contents (iris and vitreous) were more frequently left entangled in the wound. Anything protruding through the wound forms an impediment to the extension of epithelium over it.

(*d*) A change from the linear section of Graefe to the small flap incision with a conjunctival fringe.

(*e*) Preparation of the eye preceding the operation by cleansing of the eyelashes and eyelids, and irrigation of the conjunctival sac.

* *Ibid.*, vol. ix, 1879, p. 374.

† *Ibid.*, vol. xiv, 1895, p. 56.

(*f*) The use of sterilised dressings.

In suppurative inflammation of the cornea due to pneumococcal infection of operation wounds, as in suppurative ulcers of the cornea due to pneumococci, a toxin is generated, which, passing by diffusion into the aqueous, starts a suppurative iritis and the formation of a hypopyon. Should the pneumococci themselves gain entrance into the eye suppurative panophthalmitis rapidly ensues.

Just as the spread of a suppurative serpiginous ulcer due to pneumococci can sometimes be checked by vigorous use of the galvano-cautery, so, in the early stage of a suppuration after extraction, thorough application of the galvano-cautery to the infected margin of the incision will sometimes check the progress of the affection. I saw Nettleship successfully adopt this form of treatment in 1886, and afterwards recorded the results of nine cases in which it was employed.* In three the eye was saved and good vision ultimately obtained ; in three the suppurative process was checked, but flattening of the wound and shrinking of the globe supervened ; and in the remaining three the condition went on to panophthalmitis. The cases in which the procedure was most successful were those in which the galvano-cautery was used in a very early stage, within a few hours of the first indication of any suppuration starting.

Post-operative Conjunctivitis.

The following statements with regard to the bacteriology of the conjunctiva are taken from Axenfeld's well-known book on *Bacteriology of the Eye.*

He says : "It is now generally agreed that the conjunctival sac, like all other exposed mucous membranes, cannot always, perhaps even can never, be made absolutely sterile without damaging it by the very means employed."

Repeated experiments have proved that keeping an eye tied up with a bandage applied for twenty-four hours

* *Ibid.*, vol. xii, 1888, p. 179.

increases the number of organisms in the conjunctiva. This is due to (1) the loss of cleansing lid movements and diminished lacrimation; (2) the increased temperature under the bandage and congestion of the conjunctiva.

In eyes after operation which have not been bandaged, but kept shut under wire goggles, some bacterial increase occurs in the first twenty-four hours, though it is less than that which results when under similar circumstances a bandage has been employed.

If any pathogenic organisms are present in the conjunctiva they increase in number, as well as the ordinary saprophytes, when the eye is tied up.

Under these circumstances it is not surprising that after extraction of cataract, conjunctivitis sometimes sets in. It may vary considerably in severity, the discharge in some cases being copious muco-pus and in others only a slight sticky mucus. In some cases the ocular conjunctiva becomes generally injected and chemosed, in others the injection is restricted to the vicinity of the wound.

The conditions favouring its development may be enumerated as follows:

(1) The presence of conjunctivitis previous to the operation: The conjunctivitis under treatment may appear to have been completely cured. The irritation of the operation and the keeping of the eye tied up causes it to recur.

(2) Undue irritation of the conjunctiva with too strong chemical irritants used as antiseptics previous to operation: Strong antiseptics destroy the epithelial cells of the conjunctiva which protect its deeper parts from microbial infection.

(3) The leaving of soft lens-matter and blood-clot in the conjunctival sac, or of strands of vitreous humour protruding through the wound: Such structures form favourable nutrient media for micro-organisms to grow in.

(4) Laceration and excessive bruising of the conjunctiva with fixation forceps: In some elderly people the con-

junctiva is exceedingly friable, and it is difficult to take hold of it without tearing it. Some of the fixation forceps employed have unnecessarily large and numerous teeth.

(5) The occurrence of spasmodic entropion of the lower lid.

Uncomplicated Wounds of the Iris; Non-septic Posterior Synechiæ and Transient Non-septic "Keratitis Punctata."

Aseptic wounds of the iris kept bathed with uncontaminated aqueous humour show no tendency to the formation of granulation tissue. The cut surface does not become covered over, either by the endothelium of the anterior surface or the pigment epithelium from the posterior. Its appearance remains just the same as immediately after the injury is inflicted. If this was not the case, and every wound of the iris resulted in the formation of granulation-tissue, then after every iridectomy we performed broad adhesions of the iris to the lens capsule would result. The iris, like any other tissue, in the presence of any chemiotactic substance, is fully capable of reaction.

Frequently after cataract extraction one or two posterior synechiæ may form, when there are no other signs of inflammatory reaction, and when there is no reason to suspect the entrance into the eye of any micro-organisms. The formation of such posterior synechiæ is more frequent after removal of the lens than after a simple iridectomy. I would suggest that in such cases when the iris comes in contact with a wound in the lens capsule, some of the damaged and degenerating cells of the capsule by the chemiotactic substances which they generate excite plastic exudate from the iris, resulting in the formation of a localised adhesion. If this be so we can understand the importance of the early use of atropine after extraction, to keep the iris margin well drawn away from the wounded capsule. We can also find an explanation why

some operators have a preference for a peripheral incision of the lens capsule, which, if accompanied by an iridectomy, lies away from any possibility of contact with the iris.

A careful observation of cases in the early days after cataract extraction reveals in a certain number the presence of dots on the back of the cornea, which only last a short time, and which are unaccompanied by ciliary injection or any permanent defect. The dots of this "transient keratitis punctata" are sometimes grey in colour, but more frequently black. In looking through the notes of my hospital cases I find that the frequency with which it has been recorded has varied considerably with the keenness of observation of the house-surgeon. In some years no record has been made of it. In the four years, 1907 to 1910, out of 166 cases of extraction of cataract this early, slight, transient keratitis punctata is noted in 19, or 11·4 per cent. It is sometimes seen after iridectomy for glaucoma apart from any manifestations of iritis.

I do not think that the presence of a few transient dots on the back of the cornea, any more than one or two isolated posterior synechiæ, necessarily implies the entrance into the eye of septic organisms. I would suggest the following possible explanation of their formation: At the time of the iridectomy some cells of the iris from the cut surface become detached and float off in the stream of the aqueous humour. These dying and degenerating cells become deposited on the posterior surface of the lower part of the cornea, and there generate a chemiotactic substance, which attracts around them polymorphonuclear leucocytes to effect their removal.

Septic Endophthalmitis and Sympathetic Ophthalmitis.

The eyes which I have had to remove most frequently after extraction of cataract are those in which severe irido-cyclitis set in, causing closure of the coloboma with

PLATE IX.

Illustrates Mr. E. Treacher Collins's paper on Post-operative Complications of Cataract Extractions (p. 18).

Fig. 5.—Shows a section through a cicatrix after cataract extraction in which a detached piece of lens capsule has become completely embedded in fibrous tissue.

Fig. 6.—Shows a section through a limbal cicatrix after extraction of cataract in an eye in which a small prolapse of vitreous humour occurred at the time of the operation. Irido-cyclitis subsequently ensued. The conjunctiva overlying the cicatrix is seen to be much swollen with inflammatory exudate. Between the lips of the wound is a plug of tissue infiltrated with inflammatory cells, which is continuous posteriorly with vitreous humour similarly infiltrated.

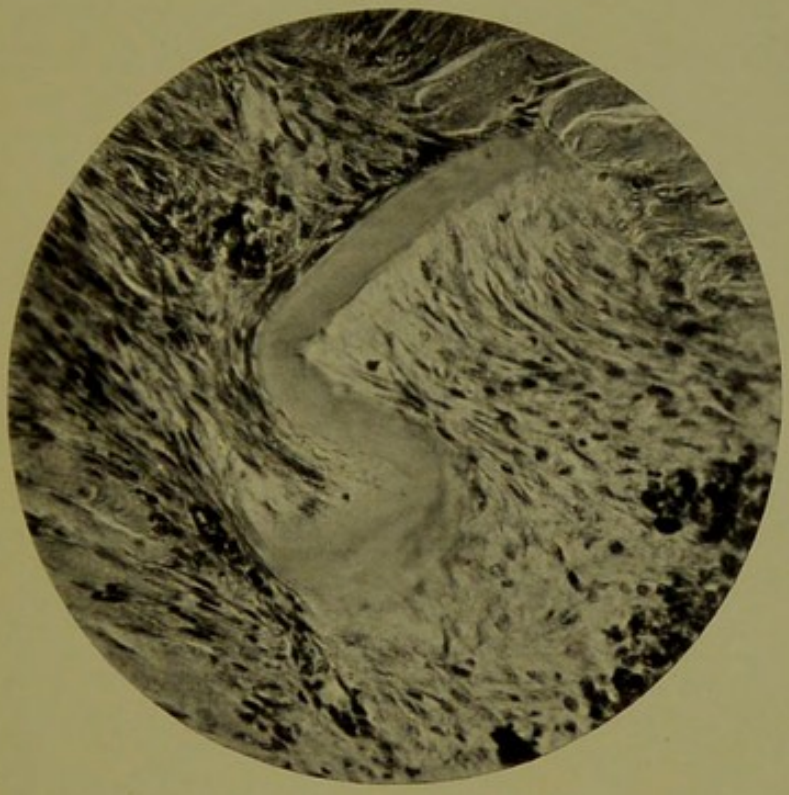

Fig. 5.

Fig. 6.

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cicatrix in which a detached piece of lens capsule is shown embedded in the fibrous tissue, without any inflammatory exudate around it (Pl. IX, fig. 5*j*. This shows that there is nothing inherent in the lens capsule itself likely to excite inflammation.

Another fallacy, to which at one time considerable credence was given and which is still sometimes referred to, is, that soft lens matter in contact with the iris excites iritis. That aseptic lens matter may lie in contact with the iris, without any inflammation resulting, we see frequently after needling operations for soft cataract. It has been shown that the aqueous humour alone is a bad medium for the growth of bacteria. If, however, an admixture of lens substance with the aqueous takes place a medium is formed which is very favourable to their growth.

A simple iridectomy, unlike an operation for extraction of cataract, is hardly ever followed by severe irido-cyclitis. Evidently the altered condition of the aqueous, by the admixture of lens matter in the latter operation, is the essential factor predisposing to this inflammatory complication.

In these cases where the inflammation has been limited to the anterior part of the eye, it has been an exudative uveitis, the exudate being of a cellular and fibrinous character, into the anterior and posterior chambers—a condition aptly termed by Fuchs,* "septic endophthalmitis."

Subacute cataract infection occurring in the human eye has been shown by Axenfeld to be due to the white staphylococcus, an organism which produced no reaction in the rabbit's cornea.

W. I. Hancock† has recorded how, in three cases of iritis following cataract extraction, Eyre obtained pure cultures of the *Staphylococcus albus* in two, and a weak growth of the xerosis bacillus in the third. *Staphylo-*

* *Arch. f. Ophth.*, Bd. lviii, Ab. 3.

† *Roy. Lond. Ophth. Hosp. Rep.*, vol. xviii, 1910, p. 56.

coccus albus and xerosis bacillus are frequently found as saprophytes in the normal conjunctiva, but there seems little doubt that when introduced into a suitable medium, such as lens-laden aqueous in the interior of the eye, they may take on pathogenic characters.

The vitreous humour is a favourable medium for the growth of micro-organisms, being poor in, or free from, protective bodies. As the stream of the aqueous is forwards from the ciliary body, in septic endophthalmitis due to the entrance of infective matter into the anterior chamber, the vitreous as a rule does not become affected. Should it, however, become opened up in the course of the operation, or should a piece of it be left lying between the lips of the extraction wound, then conjunctival saprophytes can gain entrance and grow in it, causing what Straub would term "hyalitis" (Pl. IX, fig. 6). In septic endophthalmitis of the vitreous chamber there is exudation into it from the ciliary body and from the retinal vessels.

I would suggest, then, that post-operative septic endophthalmitis is due to infection with organisms which are saprophytes in the normal conjunctiva. That their entrance into the eye is facilitated by delayed closure of the extraction wound, due to an entangled lens capsule or a prolapsing vitreous; and that their growth in the anterior chamber is facilitated by the suspension of lens matter in the aqueous humour.

As complete sterilisation of the conjunctiva is probably impracticable, the preventive treatment of this complication resolves itself into the adoption of the best means to avoiding an entanglement of lens capsule, a prolapse of vitreous, or the leaving of a large quantity of lens matter to be dissolved by the aqueous humour.

I have treated several cases, of recent years, of this complication with stock anti-staphylococcal vaccines, and in some with apparently beneficial effects. As, however, in these cases energetic local treatment with hot applications and atropine has always at the same time been employed; and as we know with this local treatment

PLATE X.

Illustrates Mr. E. Treacher Collins's paper on Post-operative Complications of Cataract Extractions (p. 18).

Fig. 7.—Shows a section through a patch of proliferative choroiditis in an eye which excited sympathetic ophthalmitis after extraction of cataract.

Fig. 8.—Shows a section at the margin of a wounded lens in an eye which excited sympathetic ophthalmitis. A granulomatous mass with a large giant-cell and epitheloid cells similar to those met with in the uveal tract, is shown in the exudate around the lens.

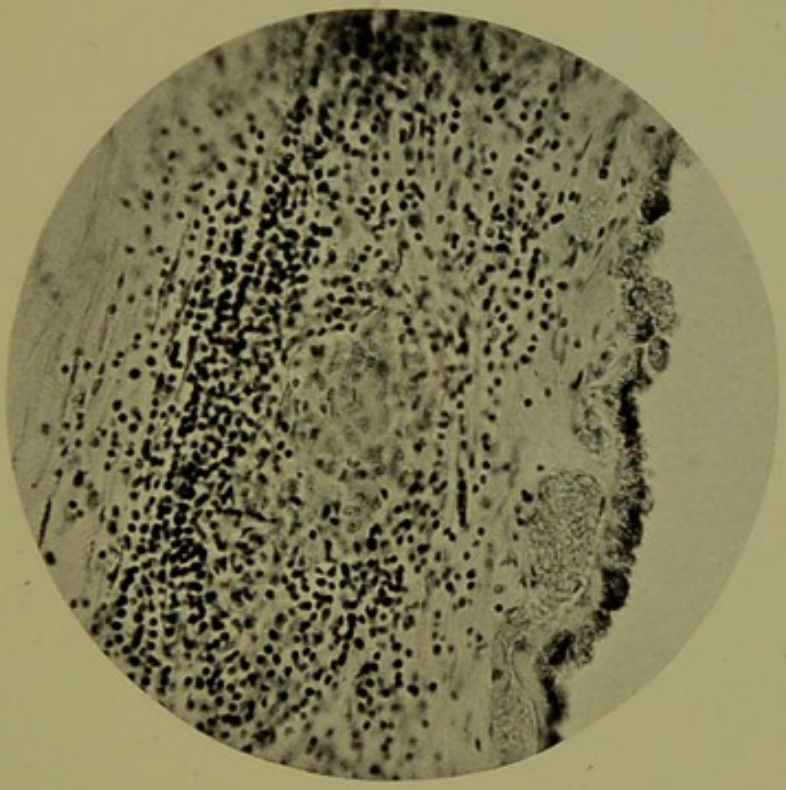

Fig. 7.

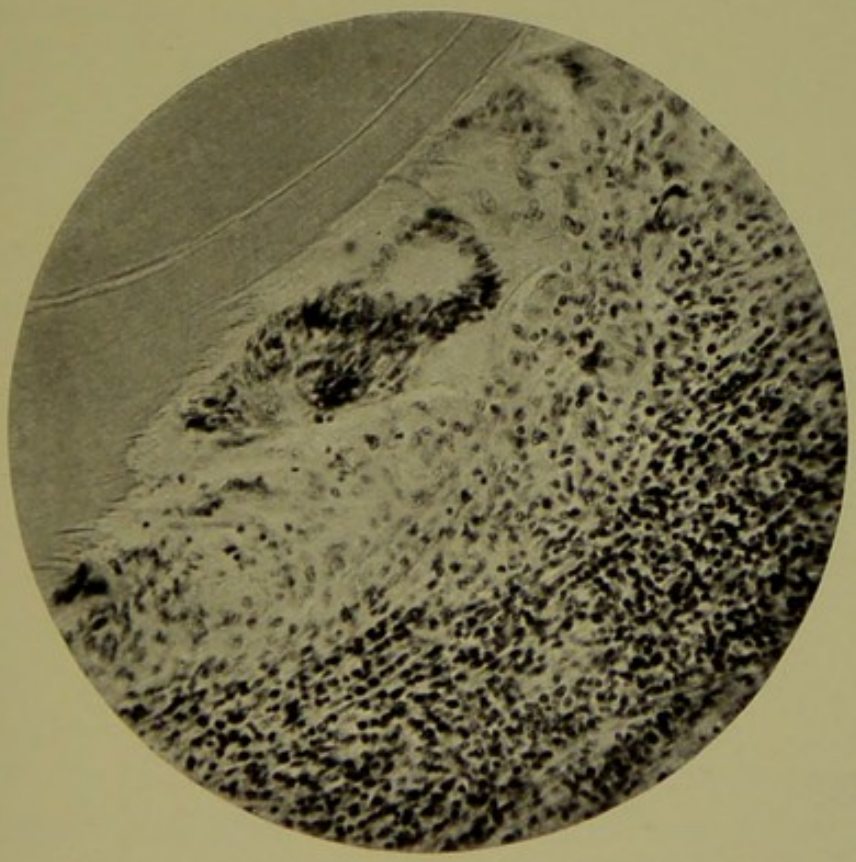

Fig. 8.

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alone some cases get well; it is impossible to be sure that the vaccines really did good.

There is, I think, considerable evidence to show that post-operative *endophthalmitis septica* is usually, if not always, exogenous in origin.

The question next arises, is there any inflammation of the uveal tract after extraction of cataract which arises endogenously?

An endogenous infection of the uveal tract would have to reach the eye by the blood, and we should expect it to manifest itself first by an inflammatory reaction in the tissue in the neighbourhood of the blood-vessels of that structure. We should expect it to be of the nature of a proliferative uveitis, rather than an exudative uveitis, which is the characteristic of *endophthalmitis septica*.

In syphilis and tubercle of the uveal tract, where there is endogenous infection, the inflammatory foci begin as granulomata in the tissue.

In eyes excised for irido-cyclitis after cataract extraction we do sometimes meet with nodules of proliferative uveitis, or of a granulomatous type. Fuchs* has shown that such nodules are usually associated with sympathetic ophthalmitis.

They consist of patches of small mononuclear cells, often surrounding large mononuclear or epithelioid cells, and having sometimes a central giant-cell with peripherally arranged nuclei. They closely resemble the early stage of a tubercular patch, but show no tendency to degeneration or caseation. They are located usually in the outer layers in the choroid, and show a greater tendency to extend outwards rather than inwards (Pl. X, fig. 7).

I have found granulomatous patches of this character in several eyes which were removed because they excited sympathetic ophthalmitis after extraction of cataract, but they were always associated with septic endophthalmitis.

These granulomatous nodules are found frequently as scattered discrete patches in the uveal tract. So that

* *Arch. f. Ophth.*, Bd. lxi, Ab. 2, s. 365.

the infective agent which gives rise to them must be disseminated throughout it by the blood-stream.

Browning has recently shown that in many cases of sympathetic ophthalmitis there is an alteration in the cellular elements of the blood, consisting in an increase of the large mononuclear cells. It seems highly probable, therefore, that the exciting agents of the inflammation in the sympathising eye are carried to it by the blood, finding in its uveal tract a suitable soil for their growth.

Meller * has suggested that in sympathetic ophthalmitis the inflammation in the exciting eye, which is the essential feature of the disease, is not, as has generally been supposed, exogenous, but endogenous in origin, the septic endophthalmitis with which it is so frequently associated, or some other disturbance in the uveal tissue, lowering the resistance of that structure and so favouring the development of the characteristic proliferative uveitis. Such an hypothesis has the merit of offering a satisfactory explanation of cases of sympathetic ophthalmitis, arising from an inflammation in an exciting eye in which there has been no perforating lesion ; as, for example, a uveitis occurring in an eye with sarcoma of the choroid.

I may point out here that I have found in eyes which have excited sympathetic ophthalmitis after operation, patches of epithelioid cells with a central giant-cell, not only in the uveal tract, but in the subconjunctival tissue, in the cornea at the margins of the unhealed wound, and in a mass of exudate around the lens which had been wounded in the performance of an iridectomy (Pl. X, fig. 8).

As I have said, in all the specimens in which I have found this proliferative uveitis after extraction there has also been an exudative uveitis. We have no means of recognising from the clinical appearances of an eye when the proliferative uveitis is present in addition to the exudative uveitis, or septic endophthalmitis. I have removed several eyes for irido-cyclitis after extraction of cataract, in which subsequent microscopical examination

* *Ibid.*, Bd. lxxii, Ab. 1.

showed that there was only septic endophthalmitis, and from which presumably there was no danger of sympathetic ophthalmitis. I have also unfortunately sometimes not removed eyes, under similar circumstances, until sympathetic ophthalmitis has set in. If in such cases a blood-count will afford sufficiently reliable evidence of the presence of proliferative uveitis, when exudative uveitis is also present, and so enable us to recognise the eyes likely to set up sympathetic ophthalmitis, then indeed we have gained a most valuable aid to diagnosis.

At a recent meeting of the Ophthalmological Section of the Royal Society of Medicine, several cases were related of remarkable improvement having occurred from administration of salvarsan or neo-salvarsan in cases of both sympathetic disease and of septic endophthalmitis.

Glaucoma.

Increase of tension after extraction of cataract may be brought about in different ways. As already mentioned it may come on some months after the operation from the formation of an epithelial lined cyst in the anterior chamber. In 1890 I read a paper before this Society based on the pathological examination of nine eyes with glaucoma after extraction of cataract. In five of the patients from which these eyes had been removed a successful cataract operation had been performed on the fellow eye without any symptoms of glaucoma manifesting themselves. This shows that there is no inherent disposition to glaucoma in the eyes of the patient affected, but that the increase of tension is the outcome of some complication arising in connection with the particular operation performed. In three of the eyes there was iritis accompanied by keratitis punctata, and the angle of the chamber was found widely open. In these cases the increase of tension was evidently due, as in other cases of iridocyclitis, to the altered character of the aqueous humour and the accumulation of cells in the spaces of Fontana.

In the other six eyes, in which no iritis or only very slight iritis occurred, the angle of the anterior chamber was found completely closed by the contact of the root of the iris with the periphery of the cornea. The advance in the position of the iris had been occasioned in five of the cases by adhesion of the lens capsule to the extraction scar. In the remaining case, in which the lens had been removed in its capsule, there was a similar adhesion of the anterior hyaloid membrane of the vitreous.

In those eyes where an iridectomy had been performed the angle of the anterior chamber in the region of the coloboma was blocked by a piece of the root of the iris, or by the most anterior of the ciliary processes, which was drawn forwards and held in contact with the back of the cornea by the upper part of the adherent capsule.

An adhesion of the lens capsule to the extraction scar does not always result in glaucoma, and in three of the nine eyes examined pathologically the increase of tension did not arise until after a needling operation. The anterior synechia of the capsule in these cases predisposed the eye to glaucoma by shallowing the anterior chamber; a still further advance, as the outcome of the needling, determined its onset. The amount of advance in the lens capsule, and of the iris in front of it, occasioned by its adhesion to an extraction scar, depends to a great extent upon the position of the incision. If it is made in the cornea the advance is necessarily greater than when it is at the limbus. An adhesion of lens capsule to a limbal incision but rarely causes glaucoma.

When the complication of glaucoma has arisen from an anterior synechia of lens-capsule, I have found that the condition can best be relieved by the division of the adhesions with Lang's knives. After the preliminary puncture with the sharp-pointed knife in the lower part of the cornea, I have inserted the blunt-pointed one and made a sweep with it across the posterior surface of the extraction-scar throughout its whole length.

PLATE XI.

Illustrates Mr. E. Treacher Collins's paper on Post-operative Complications of Cataract Extractions (p. 18).

Fig. 9.—Shows a section through the posterior part of the ciliary body in an eye which had been operated upon for extraction of cataract. The ciliary body is shown detached from the sclerotic. Part of the detachment may be due to post-mortem changes, but the wide separation of the lymph-spaces of the lamina supra-choroidea which are filled with granular coagulum, is certainly ante-mortem.

Fig. 10.—Shows a section through the region of operation in an eye from which a cataract had been extracted several years previous to its removal. A prolapse of vitreous humour occurred at the time of operation, and some years later detachment of the retina. Fibrous tissue bands adherent to the posterior surface of the corneal cicatrix are shown passing backwards. They were attached also to the retina and it was their organisation and contraction which caused its detachment.

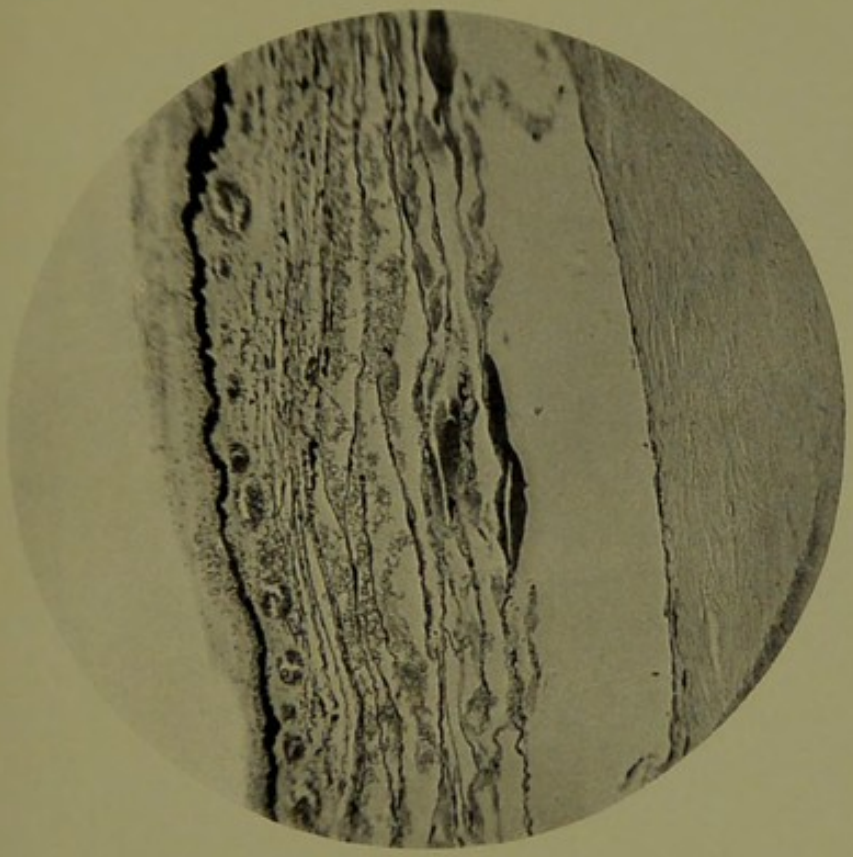

Fig. 9.

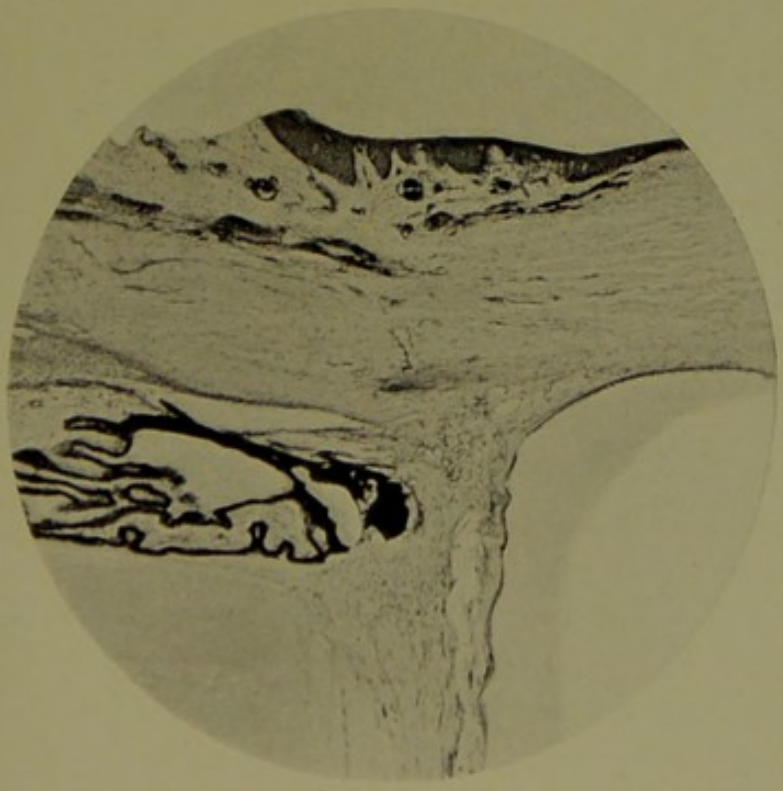

Fig. 10.

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Expulsive Hæmorrhage.

Expulsive hæmorrhage after extraction of cataract is of rare occurrence, being far more frequently met with after iridectomy for glaucoma. Out of 518 cases from 1900 to 1912 at Moorfields Hospital I have only lost one eye from this complication. The hæmorrhage in these cases chiefly takes place from the vessels of the choroid, that membrane, and the rest of the contents of the eye, being forced forwards towards the wound.

Sudden diminution of tension in the eye causes a rush of blood into the intra-ocular vessels, which, if diseased, may rupture. The diminution of tension in a glaucomatous eye is greater than in one of normal tension, and the blood-vessels are more often diseased, hence the greater frequency of intra-ocular hæmorrhage after operations for glaucoma. A slow incision which allows the aqueous humour to drain away, instead of escaping at a rush, diminishes the intra-ocular tension gradually, and presumably lessens the risk of rupture of the choroidal vessels.

Detachment of the Choroid.

Though expulsive hæmorrhage after extraction of cataract is rare, detachment of the ciliary body and choroid by a serous exudate from the choroidal vessels is probably very common. In a recent article A. C. Hudson* has shown that in most eyes submitted to pathological examination, in which there has been reduction of the intra-ocular tension from a perforating lesion, some serous detachment of the choroid and ciliary body takes place. He found in specimens hardened in Zenker's fluid, a granular coagulum in the lymph-spaces between the detached uvea and sclera (Pl. XI, fig. 9). He suggests, and I think rightly, that this serous exudate comes from the choroidal vessels, and is the direct result of the

* *Roy. Lond. Ophth. Hosp. Rep.*, vol. xix, 1914, p. 301.

lowered tension, which causes distension of them. As the normal tension is restored the exudate is absorbed and the detachment disappears. Hudson points out that in eyes with increase of tension detachment of the choroid is hardly ever met with.

The part of the uvea most often found detached is the ciliary body; it is rare for the detachment to extend posterior to the vortex veins. The detachment occurs, therefore, usually in the part of the eye which is not accessible to clinical examination, and it is impossible to determine accurately the frequency of its occurrence after cataract extraction.

Fuchs* states that if looked for detachment of the choroid can be found clinically in 4 per cent. of cataract extractions. He has met with it in cases where, after a successful operation, the anterior chamber has re-formed and then subsequently again emptied with reduction of tension. For a time the extent of the detachment may increase, but ultimately, with the restoration of tension, it will always disappear.

Probably few surgeons make a habit of examining their cataract extractions with the ophthalmoscope during the first week after operation. I have not done so myself and can, therefore, offer no evidence as to the frequency with which this complication can be detected clinically.

Opaque Membranes.

In the Erasmus Wilson lectures† at the Royal College of Surgeons in 1900 I described the microscopical appearances of different forms of membrane which I had found left after extraction of cataract. I divided them into the three following classes:

(1) Those due to retained lens matter in the capsule—a form of opacity which manifests itself soon after the operation.

* *Arch. f. Ophth.*, Bd. li, Ab. 2.

† *The Lancet*, February 24th, 1900.

(2) Those due to proliferation of the capsule cells—a form of opacity coming on very slowly, and often not causing any disturbance of vision until a year or more after the operation.

(3) Those due to the formation of adventitious fibrous tissue. These are always the outcome of some septic endophthalmitis. The more plastic the exudate the denser and tougher the fibrous tissue formed.

The frequency of the occurrence of these different forms of membrane depends largely on the method employed in dealing with the capsule and cortical matter at the time of the operation.

It may be taken as a general rule that the smaller the opening made in the capsule the sooner it is likely to become closed, and the greater the likelihood of any cortical substance left being shut off from the solvent action of the aqueous humour. When washing out of the soft cortical matter is practised the chance of opacity due to its retention must obviously be diminished.

When a piece of the anterior capsule is removed with the cells lining it by capsule forceps, not only is opacity due to retained lens matter unlikely, but also opacity due to proliferation of the capsule cells. Extraction of the lens in its capsule also prevents the possibility of opacity due to either of these conditions. The third form of opacity after extraction can only be avoided by the measures already alluded to as likely to lessen the risk of septic endophthalmitis.

Vitreous Opacities and Detachment of the Retina.

Opacities in the vitreous humour may be an accompaniment of senile cataract, the degenerative changes in both structures being due to the same nutritional deficiency. Opacities in the vitreous humour may also form as a direct sequela of the operation of removal of cataract. When a portion of healthy vitreous humour escapes from a wound and is cut off, the framework

or matrix of the structure thus destroyed is never reformed. The fluid which fills the space left vacant in the vitreous chamber has no supporting network, and is of the consistency and character of the aqueous humour. The remains of the matrix of the original vitreous become separated from its normal attachments, and often much broken up. Its detached filaments by the movements of the eye tend to run together and become entangled, so forming bodies which are seen clinically to float in the thin fluid which occupies the place of the normal vitreous.

As already mentioned, when in the course of an operation the vitreous is opened up, micro-organisms from the conjunctival sac may find in it a suitable soil for their growth. The form of septic endophthalmitis which has been termed "hyalitis" is set up, and cellular and fibrinous exudate permeates the vitreous from the surrounding parts. The exudate is usually most extensive in the vicinity of the wound—the part first to become infected. When the inflammation subsides the exudate becomes organised and persists as opaque strands (Pl. XI, fig. 10). Opacities thus formed may sometimes be seen clinically hanging down from the posterior surface of the extraction scar, and floating to and fro on movements of the eye.

When septic infection of the vitreous humour occurs after extraction of cataract there is an exudate from the retinal vessels, as well as from those of the anterior part of the uveal tract. A mild form of retinitis thus occasioned, from which the eye ultimately recovers, leaves behind adhesions of the hyaloid membrane of the vitreous to the retina. Bands are also sometimes formed in the vitreous, which, on organisation, contract, causing it to shrink and drag the adherent retina away from the choroid. Such detachments of the retina are usually late in formation, not appearing until some months or years after the operation.

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