ANATOMICAL EXAMINATION OF SIX NEW CASES OF SUBCONJUNCTIVAL FISTULA SCARS FROM FIVE MONTHS TO SIX YEARS AFTER SUCCESSFUL IRIDENCELISES OR LIMBAL SCLERECTOMIES IN CHRONIC GLAUCOMA* 

BY 

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Most microscopical examinations after iridencleisis, and especially after sclerectomies, are made on eyes of animals, mostly rabbits. The sclerectomy opening is here, without any exception, closed by a firm scar tissue; this is also the case with the human eyes with glaucoma absolutum which are enucleated for increase of tension and pain. The opening in the sclera in rabbits' eyes is soon filled with connective tissue, probably due to the fact that the new-formed aqueous in the rabbit contains a large amount of albumen and fibrin and coagulates rapidly. Dr. Sigurd Hagen has shown that this is not true for man, and that the new aqueous which forms after operations for cataract and for primary chronic glaucoma contains very little albumen and is quite devoid of fibrin.

In glaucomatous eyes which are enucleated as the result of late infection, the infiltration has effaced the usual conditions present in the scar after successful operations. It is, of course, of importance to know the reason of the failure in some cases of the modern glaucoma operations; it seems to me, however, that it is still more important to study the anatomical conditions of the scars after successful operations without any later complications. For this reason I have, since 1905, systematically enucleated after death eyes which have suffered from glaucoma, several years after successful iridencleisis or sclerectomies. As a rule I have obtained permission to hold post mortem examination on promising that the appearance of the face shall not suffer by the examination. This I have obtained by using rabbit eyes preserved in formol as prothesis, a proceeding I can recommend to pathological institutes as well as to colleagues when a post mortem microscopical examination of an interesting human eye is wanted.

At a demonstration before the Ophthalmologische Gesellschaft in Heidelberg in 1913 (Bericht, p. 355-370), I pointed out that after iridencleisis, as well as after sclerectomies, a real fistula through the limbal sclera is seen several years after the operation, if successful. I did not then give any details about the appearance of the conjunctival connective tissue covering the fistula, as pointed out by

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K. G. Ploman in his able treatise on "Sclerectomy in Glaucoma," of 1915; but I did so in a paper called "The Condition of Conjunctiva in Fistulous Scars after Iridencleisis and Sclerectomies," given September 25 at the Ophthalmological Society in Christiania, where I demonstrated several preparations.

I will now project some micro-photographs, which have not hitherto been published, of subconjunctival fistulous scars examined from five months to six years after successful iridencleisis, and also after successful trephine and punch forceps sclerectomies. Fig. 7 is photographed from a section stained with haematoxylin-eosin, the others are photographed from sections stained with haematoxylin and van Gieson. The photographs are made by Prosector O. Berner, M.D.

The conjunctiva bulbi has in all the preparations normal and unimpaired epithelium; in the more or less cushion-like part, covering the field of operation, the conjunctival connective tissue is seen to have the fibres somewhat closer together and to be somewhat richer in cells than normally, especially towards the episclera from which the conjunctiva was loosened with the keratome or scissors in the early stages of the operations. No cells show degenerative changes, all are strongly staining. In the sections stained with haematoxylin and van Gieson the intercellular connective tissue of conjunctiva shows in some places a somewhat more diffuse slightly yellowish red colour, but in none of the preparations are seen signs of hyaline degeneration.

The special microscopical conditions of the preparations will be described separately below each picture. In this description I have enjoyed the valuable help of F. G. Gade, M.D. At the same time I will give a short summary of the account of the clinical conditions in each eye.

1. N. F., late teacher, aged 65, of Christiania, January 8, 1900; complains that the sight of right eye has constantly been decreasing in the course of the last two years. Both eyes feel hard; the discs were pale with excavation to the edges upwards and outwards. R.E.: T. + 2, V.č+4.5 = 5/10. Great reduction of both nasal visual fields and a curved Bjerrum scotoma close below the fixation point outwards to the blind spot. L. E.: T. +1, V.č+5.0 = 5/8; a small sector was absent from the field of vision on the nasal side horizontally about 25° from the fixation point, but otherwise the field was full. The reduction of the visual fields constantly increased in spite of constant use of miotics. Iridectomy of the right eye was done on January 30, 1901 and a similar operation on the left eye on February 6. But there was a constant aggravation and the tension did not decrease in spite of reassumption of miotics. November 7, 1905, R.E.: doubtful counting of fingers half a metre away, with a remnant of the visual field temporally to the blind spot;
T. 10/3 Schiotz (51 mm. Hg.). L.E.: V. = 5/60; visual field shows nasal reduction to 8° from the fixation point and curved Bjerrum scotoma above as well as below to the blind spot. T. 10/4 (46 mm. Hg.).

November 10, 1905: Iridencleisis simplex R.E.
November 13, 1905: Iridencleisis simplex L.E.

In both cases a fold of iris at the periphery of the temporal coloboma was drawn out through the angle of the subconjunctival keratome incision. A somewhat raised and soft cushion developed over the scars with surrounding oedema which increased by massage; there was no thin bubble. The tension ever since has been tonometrically normal in both eyes without miotics. December 18, 1907: R.E.: V. =: counts fingers at one metre; a small island of central visual field seems to be re-established. L.E.: V. = 5/24; visual field unchanged. Both eyes: T. 5.5/4 (21 mm. Hg.). For the years 1908 and 1909 I have no notes, but the patient's sister believed that the sight of the left eye remained

FIG. 1.

N. F., died January 13, 1910, aged 75. L.E.: Axial vertical section (magnified 18/1) through subconjunctival iris fistula after iridencleisis simplex on November 13, 1905, at the coloboma periphery in an eye operated by iridectomy four years and a half earlier. The conjunctiva near limbus was raised into a cushion which pits on pressure and is without any thin bubble. The surrounding oedematous area was increased by massage. The fistulous track is lined with pigment epithelium throughout the oblique subconjunctival keratome incision and ends in a cyst, also formed by iris tissue, outside sclera. The inner wall of the cyst is only partly lined with pigment epithelium, but in the surrounding conjunctival connective tissue, in some places, a few scattered pigment cells occur and, in higher magnification, some loose pigment granules may be seen.
unchanged till the death, January 13, 1910. Eyes enucleated 38 hours after death. The subconjunctival iris fistula of left eye is shown in Fig. 1.

2. Mr. X., aged 69 years 4 months, Nordland. February 17, 1908: R.E. blind for two years. L.E.: the sight failing during the last year in spite of constant use of miotics. V. = 5/36. Visual field: upwards 45°, temporally 55°, downwards 28°, nasally 12°; curved Bjerrum scotomata both over and under the fixation point outwards to the blind spot. Tension of both eyes 5.5/3 (25 mm. Hg.); in similar cases I have proved that the tension is higher in other hours of the day than in the oculists' consulting hours. After treatment of lacrymal obstruction on the left side and of chronic conjunctivitis in both eyes I performed on March 11: *Iridencleisis cum iridotomia meridionali* on the right eye and on March 15 the same operation on the left eye. March 26: L.E.: V = 5/18; visual field somewhat enlarged. Both eyes: T. 15.5 mm. Hg. August 11, 1908: consulted a colleague for abdominal complaint who diagnosed cancer of the pylorus. August 14: L.E.: V = 5/18; visual field upwards 50°, temporally 80°, downwards 65°, nasally 44°; the lower Bjerrum scotoma has disappeared, the upper scotoma reaches now from the blind spot to the vertical meridian. No *conjunctival oedema over the flat scar*; T. 18 mm. Hg. By light massage of the globe no conjunctival oedema was produced, but the tension was thereby lowered to 15.5 mm. Hg.
R.E.: T. 18 mm. Hg. and by light massage 15.5 mm. Hg.; here was seen a thin bubble over the scar and diffuse conjunctival oedema. August 16 the patient died suddenly (heart failure). Eyes enucleated August 18, the bulbar conjunctiva being incised at equator. By microscopical examination of both eyes there was seen a well-developed iris fistula through the scleral incision. In the right eye the fistula ends in a little cyst in the oedematous conjunctiva. In the left eye (Fig. 2), the fistula continues for a

FIG. 3.

G. H., died March 12, 1914, aged 72. Left eye. Axial vertical section (magnified 18/1) through a subconjunctival iris fistula after iridencleisis cum iridotomia meridionali upwards, April 4, 1908. Conjunctiva over the encleisis forms a flat and soft cushion without any bubble but with surrounding oedema which increased by massage. The fistula lined with pigment epithelium is enlarged upwards, outside the keratome incision, to a small funnel-shaped space, the walls of which are only partly lined with pigment epithelium. The funnel sends a prolongation backwards into the episcleral tissue. Some few pigment cells, and a few loose pigment granules, are seen in the connective tissue of the covering conjunctiva.

while episclerally and ends in a subconjunctival fissure; by comparing a number of serial sections this fissure is seen to communicate with Tenon's capsule.

3. G. H., Ph.D., aged 64, Christiania, February 5, 1908: For a couple of years he has observed, in both eyes, an increasing
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reduction of the nasal visual field; with his amateur knowledge of physiology he believed this was due to an incurable brain complaint, and for this reason he had not till now consulted an oculist. Both eyes: discs pale with excavation to the margin; nasal quadrants of the visual field are wanting nearly to the vertical meridian; in the left visual field there is also a Bjerrum scotoma below the point of fixation. R.E.: V.c+4.5=5/12; T. 7.5/3 (36 mm. Hg.). L.E.:
right eye. In each eye over the enucleisis a flat conjunctival cushion appeared without any thin bubble, but with surrounding oedema which increased on massage. The tension became at first subnormal, but later normal (18 to 21 mm. Hg.) without miotics, which were not used at all during the remaining six years of his life. The nasal quadrants of the visual fields were considerably re-established, and the temporal ones kept so that the patient could see quite well; the first four summers after the operations he took walking excursions alone in the Jotunheimen and photographed mountain panoramas. When I saw him last on September 19, 1912, I found R.E.: V. c 4.5 still = 5/12 and L.E.: V. = 5/18 (somewhat better than before the operation). March 12, 1914, he died of complications of prostatic enlargement. His landlady told me that he had read books up to the last. Both eyes were enucleated 38 hours after death; the subconjunctival iris fistulae are shown in Fig. 3 (left eye), and Fig. 4 (right eye).

4. E. N., aged 54, female teacher, Christiania, December 18, 1911. Sight of left eye blurred for several months; she has not had pain and has not perceived any coloured rings round the light. L.E. is not injected, but the surface of the cornea is hazy, the pupil is enlarged (6 mm.) and reacts slowly to light. The disc shows a shallow excavation to the margin but is not pale. V. c correction = 5/15. The visual field is reduced 20° in the two temporal quadrants and somewhat more in the two nasal ones. T. 15/5 (61 mm. Hg). R.E.: the pupil on an average 4 mm. reacts well. Fundus normal. V. c correction = 5/5. Visual field nearly normal, 10° at most, contraction in the nasal quadrants. T. 7.5/3 (36 mm. Hg). She would not at first hear of any operation: eserin 0.5 per cent. four times a day in the left eye, pilocarpin 2 per cent. twice a day in the right eye was prescribed. January 8, 1912: Tension of the left eye is very little improved (10/3 51 mm. Hg.), the tension of the right eye unchanged in spite of the use of miotics.

January 9, 1912. L.E.: Trephine operation upwards with a trephine of 2 mm. without splitting of the cornea as there was plenty of room to get into the anterior chamber; basal iridectomy was performed.

January 17, 1912. R.E.: Limbal sclerectomy upwards of the anterior lip of the wound with a 3 mm. wide Holth's punch forceps; scleral excision 1.5 × 3 mm. basal iridectomy.

In both eyes appeared a glassy conjunctival cushion upwards and a thin glassy bubble, through which the sclerectomy defect was seen as a black opening, at first original size, later smaller (see the texts under the pictures Fig. 5 and Fig. 7); round the cushions appeared a diffuse oedema which increased by massage. Tension at first subnormal, later normal. The visual field became quite normal in right
E. N., died May 6, 1915, aged 57. L.E.: Axial vertical section (magnified 18.1) through the centre of the limbal sclerectomy defect upwards after a 2 mm. trephining made January 9, 1912; no splitting of cornea; basal iridectomy. A glassy conjunctival cushion was developed with a thin glassy bubble above limbus; through the bubble the scleral defect was for a long time seen as a black round hole of 2 mm. in diameter, but the black hole after a time became smaller and on January 30, 1915, it appeared as a 0.75 mm. wide black opening in the middle of a grey field corresponding to the original trephining. The conjunctiva with normal epithelium passes over the defect, but in the deeper subconjunctival layers it is condensed as shown in the photograph by the part staining deeply which by magnifying 135/1 is seen to consist of a denser connective tissue, somewhat rich in cells, with fibres running chiefly in meridional direction; near the anterior edge of the light opening the fibres in the deeply stained area run in a circular manner. In the anterior (corneal) wall of the scleral defect the denser connective tissue originates exclusively from the subconjunctiva; in the posterior (ciliary) wall of the defect, the condensed tissue consists of two layers, the uppermost one proceeding from subconjunctiva, the deeper one proceeding from the scleral wall itself; on the border between the two layers are seen episcleral vessels. In the middle of the darkly staining tissue which I have called "the subconjunctival cicatricial covering" is seen a spongy connective tissue with extremely fine largely meshed fibres and with very few scattered cells. This tissue is continued upwards towards the surface even under the normal epithelium. In the circumference of the light part this tissue gradually changes into a denser tissue which is more rich in cells. The anterior (corneal) wall of the defect is lined with a thin layer of dense connective tissue with vertically running fibres and with endothelium from Descemet's Membrane; this endothelium is not seen elsewhere on the walls of the defect.
eye and nearly normal in left eye where V. rose from 5/15 to 5/7.5. Last note January 30, 1915. R.E.: V. c correction 5/4; T. 5.5/5 (18 mm. Hg.). L.E.: V. c correction = 5/7.5; T. 5.5/3 (25 mm. Hg.); pilocarpin 2 per cent. was now ordered for the left eye, twice a day. May 6, 1915, she died suddenly (apoplexia pontis Varolii). Both eyes were enucleated 43 hours after death. The subconjunctival sclerectomy fistulae are shown in Fig. 5 and Fig. 6 (left eye) and Fig. 7 (right eye).

FIG. 6.

Axial vertical section 0.5 mm. temporally to the section photographed in Fig. 5. In Fig. 6 the dense darkly-stained subconjunctival cicatricial tissue covers the scleral defect completely.

The light area in the centre of the dark in Fig. 5 and the corresponding two light areas in Fig. 7 may be explained in a similar way as I explained five years ago such a light area in Fig. 8 in Heidelberger Bericht, 1913, p. 365; that the aqueous has forced its way through the cicatricial roof of the scleral defect and made a secondary fistula in the subconjunctival tissue communicating with the original one in the sclera. Such a breaking through might be expected to take place during the first weeks after the operation while the subconjunctival scar tissue is still soft and succulent. As far as the
E. N., died May 6, 1915, aged 57½. R.E.: Axial vertical section (magnified 18/1) through a subconjunctival scleral defect upwards after a limbal sclerectomy, on January 17, 1912, 7.5 x 3 mm. large; basal iridectomy. A glassy conjunctival cushion was developed, with a thin glassy bubble over limbus. The sclerectomy defect was first seen through the bubble as a black opening in its original size, which after a time somewhat decreased and was divided in the middle into two halves by a nearly meridional, and slightly oblique grey string in the depth of the opening. The photograph shows a defect in the sclera with the posterior (ciliary) wall sloping upwards and backwards, the anterior (corneal) wall on the other hand is steep and has rounded edges. The defect in the sclera is everywhere covered with the conjunctiva whose epithelium is normal; the conjunctival connective tissue is somewhat denser and richer in cells than elsewhere away from the operation field. The anterior (corneal) wall of the defect is lined with a layer of connective tissue the fibres of which run in a vertical direction to the course of the sclero-corneal fibres. This layer of connective tissue is lined with endothelium from Descemet's Membrane, but the endothelium does not continue on the under surface of the conjunctival covering of the defect in the sclera or on the posterior (ciliary) wall where the scleral fibres end quite free without any sign of a reactive process. In the darkly stained connective tissue of the conjunctiva over the scleral defect there are seen two lightly staining areas which by magnifying 135/1 proves to consist of a spongy connective tissue with extremely fine largely meshed fibres and with very few scattered cells. One of these lightly staining areas is seen near the limbal insertion of the conjunctiva, reaches close under the epithelium, but is in the section shown above interrupted by a denser bridge of connective tissue which appears dark in the photograph and corresponds to the oblique grey string across the scleral defect which was visible through the thin glassy bubble. The second lightly staining area is seen in the posterior part of the conjunctival covering of the scleral defect, but this area is separated from the epithelium by means of denser connective tissue.
two actual scars (Fig. 5 and Fig. 7) are concerned, however, I do not believe this explanation will do, especially not in the case of the trephining fistula. My observation given in the text under the picture Fig. 5, about the gradual shrinking of the trephining defect from the periphery, as seen through the thin glassy conjunctival bubble, makes it likely that the process has been different in this case. The subconjunctival scar tissue has been slowly developed from the edge of the trephine opening at the expense of the lightly staining connective tissue which from the beginning covered the whole of the opening. If the patient had lived longer the fine spongy tissue might entirely have been transformed into denser connective tissue and the opening completely closed; I have clinically seen instances of such cases. I wish to draw attention to the fact that a scleral tissue has been developed from the posterior (ciliary) wall of the scleral defect after the trephining (Fig. 5), while

this wall does not at all show any reaction after the clean cut keratome incision for sclerectomy with punch forceps from the anterior wound lip (Fig. 7).

I believe that the preparations from which the photographs Fig. 5 and Fig. 7 are taken very well explain the phenomenon discovered by Dr. Erich Seidel by means of a fluorescein test on the scar after many cases of sclerocorneal trephining; the aqueous oozes out on the surface of the eye from the thin conjunctival bubble; this bubble at first becomes green by fluorescein, then the oozing aqueous in a slow stream following the law of gravitation washes the green colour away. The quantity of the oozing aqueous was measured by a special test—in one case it was 2 milligrammes per minute (Arch. f. Ophthal., 1920, Vol. CII, p. 371, and Vol. CIV, p. 158).

I have no doubt that this phenomenon might have been found in both eyes with my patient, E. N., from which Fig. 5 and Fig. 7 are taken. If this had been the case the way of the aqueous must have been through the scleral defect and through the opening in the denser subconjunctival cicatricial tissue into the light spongy tissue.
reaching to the apparently normal epithelium, by enlargement 135/1. For this reason the aqueous must be supposed to have oozed out through the intercellular spaces of the epithelium; in his cases Dr. Seidel could not, under Gullstrand lamp and corneal microscope, see any epithelial defect in the conjunctival bubble.

The cause of the oozing must be that the denser connective tissue surrounding the bubble forms an obstacle to the subconjunctival passage of the aqueous. In spite of a normal tension being obtained by this oozing of the aqueous, I consider this condition undesirable because it affords an easy way to late infection.

Dr. Harald Gjessing who first drew my attention to Seidel's fluorescein test in trephining scars, after successful iridencleisis, has till now found the test positive in one case only where a thin conjunctival bubble had appeared; in cases with a cushion without any bubble but with surrounding diffuse oedema or with the latter condition only, neither Gjessing nor myself can find Seidel's phenomenon. This statement applies also to the cases I have examined after successful tangential extralimbal sclerectomy with

![fig. 9]


punch forceps; in one case, operated November 18, 1920, with a 1.5 mm. broad punch forceps where, half a year after the operation, was seen a conjunctival cushion with a bubble* more than 1 mm. from the limbus the fluorescein test was also negative probably because the bubble had thicker walls than the epithelium.

As the appearance of the thin conjunctival bubble must be supposed to depend on cicatricial obstacles to the subconjunctival passage of the aqueous, I believe that the quantity of subconjunctival cicatrical tissue should be reduced as much as advisable in the modern operations for glaucoma. For this purpose, I believe that the length of the incision for the conjunctival flap in the tangential punch forceps sclerectomy (this journal, 1921, p. 547, Fig. 5) may be somewhat reduced; or the subconjunctival tunnel may be made as in most of my iridencleisis operations and in several sclerectomies (Annales d'Oculistique, 1909, Vol. CXLII, p. 1, Fig. 11 and Fig. 12).

The diagram Fig. 8 shows the tangential extralimbal sclerectomy with punch forceps through a subconjunctival tunnel.

*After tangential extralimbal sclerectomy with the 1 mm. broad punch forceps I have till now seen a cushion and oedema only and not any bubble.
The bulbar conjunctiva must be undermined to limbus and lifted with forceps while the scleral excision is made; during the iridectomy (basal as in Fig. 8, or complete) an assistant must draw the conjunctival incision down to the sclerectomy defect by means of a U-shaped blunt double hook (Fig. 9).

The small conjunctival incision ought to be closed by a suture: first half of the surgical knot; the suture is removed after 48 hours. In performing the different subconjunctival operations for glaucoma, the blades of the speculum ought to be short in transverse direction; by this means the palpebral fissure is well opened vertically, and thus plenty of space is obtained for the formation of the conjunctival flap or the subconjunctival tunnel.

The subconjunctival tunnel may be made with the keratome itself and completed to the limbus with scissors, or made with scissors only before the keratome incision. Dr. E. Lindgren makes only the short conjunctival incision with scissors; he makes the tunnel itself by a blunt detachment of the conjunctiva down to limbus, e.g., with closed scissors. By this proceeding the vessels are probably less hurt, which must be considered an advantage. Elschnig (Arch. f. Ophthal., 1921, Vol. CV, p. 599) has shown that the conjunctival cover of the trephine aperture is devoid of vessels. Elschnig also believes that the aqueous has tissue-dissolving qualities, which, in his opinion, is proved by the fact that a loose scleral disc fallen into the anterior chamber during trephining, as a rule has completely disappeared in a relatively short time. The best possible vascularisation of the covering conjunctiva may counteract this hypothetical dissolving quality of the aqueous.

[Dr. Holth writes that the title of his paper in the last number of this Journal should have been: "A New Technic in Punch Forceps Sclerectomy for Chronic Glaucoma: Tangential and Extralimbal.—Iridencleisis Operations resumed 1915-1919."—Ed.]

THE IMPORTANCE OF PSYCHICAL INHIBITION (NEUTRALIZATION) IN BINOCULAR SINGLE VISION

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Dr. Javal, of Paris, has published evidence of the existence of neutralization of part of the retinal image of a squinting eye in order to avoid diplopia. It has also been shown that diplopia is common in the early stage of the development of a squint. This diplopia is caused by the projection of the retinal images of an object to non-corresponding parts of the two retinæ. In another series of experiments Javal has shown that diplopia does not occur even when the sizes of the two retinal images are very different. This question had been discussed in former times and was con-