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To Professor Spence

Glaucoma:
its nature and treatment.

Well arranged & practical.

Alfred Bullar.
Glaucoma.

On no subject connected with ophthalmic science has there been greater obscurity than on the nature of Glaucoma. And it is only in recent times that the phenomena of this disease have been accurately investigated. — Having observed several cases of glaucoma, my attention was directed to this subject as a suitable one for this Thesis. —

In treating of the pathology of glaucoma, I have been greatly aided by the works of various authors, and I have endeavored to review the modern observations on this interesting subject. —

As the term "glaucoma" includes several forms of disease, it is requisite to define accurately these various morbid conditions. — Glauomatous diseases are a class, comprising various types, all characterized by augmented tension of the eyeball, under which the Retina is compressed and destroyed. The phenomena may be arranged in four stages viz.: 1. A precocious period — glaucoma incipiens of Graefe. 2. A period in which the disease is fully developed — glaucoma evolution. — 3. — A period when quantitative perception of light is entirely lost — glaucoma.

Such are the stages of the disease appearing in most cases. In treating of the symptoms and pathology of glaucoma, I propose to limit my observations to the acute inflammatory form of the disease.

Symptoms of Glaucoma. There is usually a preliminary period preceding the acute symptoms; this is rarely absent, but its duration is very variable. The preliminary symptoms occur at intervals. There may be occasional vague pains in and around the eye, accompanied by dimness of sight. Luminous spectra are occasionally seen. This latter symptom being due to the morbid inunction of the retina. The tension of the eyeball is increased, and this varies in degree, as the pupil tends to show a marked tolerance of pressure that is only gradually increased, and a marked intolerance of the same when suddenly produced. While, therefore, in cases of very gradually increasing tension, the symptoms may be slight, it is much more common to meet with patients in whom, a more rapid rate of increase, is productive of more or less inflammatory reaction. As glaucoma is a disease almost peculiar to old people, its
Subjects are frequently presbyporic, and it has been observed that this defect of vision increases during the premonitory stage of glaucoma. — This seems to be due to the action of the increased intra-ocular pressure upon the nerves supplying the ciliary muscle, causing paralysis of that structure. The hardness of the globe is associated with a dilated state of the pupil.

The aqueous and vitreous humors become clouded and hazy. — This cloudiness is variable in degree and duration; in some cases, it is so slight as to be scarcely perceptible, in others, it is well-marked. It may exist continuously, or merely come on at intervals. — But we may, here, notice that the blindness does not depend upon this opacity. — These premonitory symptoms occur more frequently as the disease progresses, and become a source of great anxiety to the patient.

The acute stage usually supervenes suddenly, the symptoms being violent pain in and around the eye, rapid and complete loss of sight, and frequently there is great constitutional disturbance. The acute attack frequently comes on during the night, and the patient is roused from sleep by the intense pain in the eye and head. Sometimes the pain
extends around the head and down the corresponding side of the face. - At the same time the eye appears intensely inflamed, the conjunctiva is injected and even chemosed, and a vascular zone is observed around the cornea: there is also copious lachrymation.

The eye-ball is intensely hard, and the pupil is widely dilated and motionless. - The cornea appears dull and its sensibility is diminished: the sclera, media also are clouded and opaque. -

After a time the symptoms may become less violent, and vision partially restored: - these inflammatory exacerbations, however, occur at intervals, and in course of time, the condition of glaucoma abolition is induced - the eye being destroyed and vision entirely lost. - The stage of glaucomaous degeneration then ensues, and a series of atrophic changes secur, - "the lens becomes opaque, the iris is reduced to a narrow streak, and the cornea is opaque and softened: hemorrhagic effusions take place into the anterior chamber, the vitreous humour, and the inner tissues of the eyeball."

With regard to the predisposing causes of glaucoma,
There is still much uncertainty. It has been observed by Von Graefe that this disease occasionally occurs in cases of advanced sclerotic choroidal staphyloma and inter-choroiditis, and this observation has been confirmed by subsequent observers. It has also been observed that patients with hereditary joint and arterial of the arteries, are predisposed to glaucoma, but this appears to be extremely doubtful.

Some injuries to the eye - especially those penetrating the ciliary region and lens, are prone to cause the glaucomatous condition. It has been noticed that the sclerotic appears peculiarly rigid and unyielding in glaucoma, and hence it has been supposed that this condition is not infrequent by congenital, and may form the predisposing element in the disease. — M. Helle remarks: “At present, we only know that a certain period of life, an enfeebled constitution, prolonged mental anxiety and broken rest predispose to the appearance of glaucoma.”

Pathology of Glaucoma. In tracing the history of this disease, we find that the word "glaucoma" was first used by Hippocrates to designate all the
Opacities situate behind the pupil of the eye: and, by subsequent authors, the term was limited to those opacities which are characterized by a greenish-opaque appearance.

As the anatomy and physiology of the eye were investigated, in later times, so also were the diseases localized, and two theories of glaucoma were proposed viz. 1st that the opacity was caused by a change in the colour and consistency of the crystalline lens and 2nd that it was due to the deposition of a morbid product between the iris and lens. — The former theory seemed to be supported by the pathological facts, as the lens was found to be discoloured and hardened: but as we now know, this change in the state of the lens is merely one of the results of the morbid process. — The 2nd theory was that of Bissecarie who announced, as the result of his dissections, that glaucoma was an opacity of the vitreous humour. — This author observed one of the secondary phenomena of the malady, and the real origin of the morbid process remained obscure. — The progress of science was but slow, and Bissecarie's theory
were accepted by subsequent authors. For, in their works we find glaucoma defined thus— "an opacity of the Hyaloid membrane and of the fluid contained therein."

Hardorp states that "in some cases, the Vitreous humour acquires a dull greenish color accompanied with insensibility of the Retina, a species of hemmorrhage which is termed glaucoma."

In later times, the researches of St. Hilaire appeared to prove that the most important pathological change was situated in the crystalline lens, as shown by the following appearances: 1st. On removing the lens by operation from a glaucomatous eye, the pupil no longer presents the glaucomatous color, but appears bleaker as natural. 2nd. In dissection of glaucomatous eyes, the lens is found to be, especially in its central part or nucleus, of a yellowish-red color when viewed by transmitted light, greenish when viewed by reflected light.

The above observations seemed to be conclusive, but it is now known that the lens undergoes certain physiological changes in old age; now its color becomes changed— it assumes a yellowish tincture. It therefore seems probable that in the
cases examined by Mackenzie the lens had undergone this peculiar degeneration. As the diagnosis of glaucoma was but obscure, and as the disease seems chiefly in old people, we may conclude that this colouration of the lens noticed in the cases examined was not, by any means, pathognomonic of glaucoma.

During the glaucomatous degeneration, it has been noticed that the lens, not infrequently, assumes a yellow tint; and the peculiar green appearance which is so characteristic of the glaucomatous eye, seems to be caused by the blending of the yellow tint of the lens with the bluish colour of the aqueous humour.

Of the modern theories regarding the pathology of glaucoma, that one enunciated by Schwindan der Holth, was most generally accepted. The pathological facts supporting this theory were that, on dissection of glaucomatous eyes, effusions were found to exist between the choroid and retina, and this seemed to point to inflammation of the choroid, as the source of the glaucomatous process. Subsequent investigation has partially confirmed the accuracy
of this theory; but the great dissection was some means of observing the deep-seated structures of the of the eye during life. Then came the great discovery of the ophthalmoscope by Helmholtz in the year 1857; and by this means, a new field of investigation was opened up, and the limits of ophthalmic science vastly extended. Previous to the introduction of that instrument as an aid to diagnosis, all our knowledge regarding the pathology of the deep-seated structures of the eye, was obtained from the post-mortem appearances, and the objective symptoms. The direct examination of the fundus of the eye during life, revealed a new series of phenomena; and various morbid conditions, the nature of which, was unknown previously, were now within the reach of ob-
servation.

The ophthalmoscope was applied to the investigation of glaucoma, and, after a time, the researches of Läger and Von Graefe sufficed to prove that, in all cases of this disease, certain changes are observed in the fundus of the eye. The first-change observed was
a peculiar alteration in the form of the optic nerve entrance. — That structure was observed to be excavated or "cupped." The retinal vessels also appeared congested, and in some cases, pulsation of the arteria centralis retinae was observed. The excavation of the optic disc is indicated by a bluish-gray color of its periphery, and by a peculiar arrangement of the veins. The essential phenomena of glaucoma are the venous hyperemia, and the increase of the fluid content of the eyeball. The continued existence of this intra-ocular tension produces compression of the retina and consequent loss of sight. The excavation of the optic nerve is due to the increased pressure; but "cupping" of the disc may occur from other causes, that it may be congenital, or it may be the result of atrophy of the optic nerve. The excavation of the disc due to glaucoma may be distinguished by the following characteristics: the "cup" extends quite to the edge of the disc, the edges are abrupt, and the retinal vessels curve abruptly over the margin. These changes in
the fundus of the eye. Having been ascertained to be pathognomonic of the glaucomatosus process, the next subject to which the attention of all observers was directed, was the relation of such changes to the symptoms of the disease. The hardness of the glaucomatosus globe had long been known to ophthalmic surgeons; and, as we have seen, all the symptoms indicate increased intra-ocular pressure. This increase of tension seems to be due to an increase in volume of the vitreous humour, owing to inflammation of the uveal tract, which is the chief secreting organ of the ocular fluids: it appears also that the powers of absorption are diminished in glaucoma, so that the effusions are not removed by increased activity of the absorbents, as in the other forms of choroiditis. All Wells accounts for this diminution of the power of absorption, by the changes in the coats of the vessels and by the great tendency to over-fullness and stagnation in the blood-vessels during the inflammatory exacerbations of glaucoma. — Von Graefe.
also maintains the inflammatory nature of glaucoma, accompanied by an increased secretion of the fluids of the eye, and by augmented tension.

The choroid is liable to various circulatory and trophic disturbances: in some cases, the ophthalmoscopic signs are well-marked, in others, no morbid changes are observed. In the early stage of glaucoma, choroidal ecchymoses are usually seen, and the Iris always is affected during the course of the disease. The turbid condition of the Vitreous humour also favours the opinion that the Choroiditis is the origin of the disease. Of all the internal structures of the eye, the choroid is the most vascular, and its vessels freely intermingle with those of the iris and ciliary processes; so that we may conclude that the inflammatory process attacking the choroid, necessarily involves all the structures connected with it, and greatly disturbs the nutrition of the eye-ball. The ophthalmoscopic examination confirms the opinion that glaucoma is essentially a choroiditis;
The Retinal veins appear dilated and congested. The capillaries are tufted and sacules are formed on them; and there with the capillaries on which they are situated, are often observed to be crammed with blood-corpuscles. Small extravasations of blood, traceable to ruptures of these sacules, are not infrequent; they are confined to the inner layers of the Retina, or burst into the Vitreous humour.

In several cases, I have observed patches of extravasated blood in the Retina. All this indicates an unusual resistance at the optic disc to the efflux of blood through the Veins centralis and consequent increase of the blood-pressure on the inner surface of the vessels. As to the condition of the Vitreous humour in glaucoma, it has been found to be peculiarly consistent, and it is only in the later stages of the disease when degeneration has occurred, that it becomes more fluid than in the normal state.

In account of the occasional occurrence of cases of glaucoma simply without apparent inflammatory symptoms, and on account of the increased tension being sometimes the first
manifest symptom of the disease, it has been sus-
pected by Dr. Henders and others, that the inflammation
is not the essential part of the glaucomatos process,
but only a complication which, though occurring
in the majority of cases, need not necessarily be
always present. Dr. Henders considers the
increase in the intra-ocular pressure as the essential
part of the disease; the anomaly in the secretion
of the fluids of the eye, he thinks due to an ab-
normal irritation of the nerves regulating the
intra-ocular nutrition. — But Von Graefe states
that, in these cases of apparently non-inflammatory
glaucoma, a lengthened observation will generally
show us that transient inflammatory exacerbations
occur. — We have seen that the pathol-
ogical facts are in favour of the theory of in-
flammation of the choroid. —

We may notice an ingenious theory of glaucoma
proposed by Dr. Hanecch: This attributes all the
symptoms to a spasmodic contraction of the ci-
ary muscle, compressing the ciliary nerves, and
obstructing the circulation. We cannot, however,
thus explain the varied phenomena of glaucoma.
In conclusion, with regard to the pathology of glaucoma, in the words of Stellwag—"If all the bearings of the case be considered, and all the older, as well as the more recent observations both with the microscope and the ophthalmoscope, be taken into account, it will appear that glaucoma consists essentially of a venous hyperemia, and an inflammatory process extending to all the internal parts of the eyeball—a process that is followed by a very considerable increase of the intra-ocular pressure, by early excavation of the optic nerve, and by a decided tendency to atrophic degeneration of the interior structures of the eye. The conjoint participation of all these internal structures is essential to the idea of glaucoma".

Having thus briefly considered the pathology of glaucoma, I proceed to discuss its treatment, with special reference to the modern operation of iridectomy. Glaucoma was long regarded as an incurable disease, and only palliative measures
were adopted for its relief. The older ophthalmic surgeons adopted such treatment as venesection, leeching, blistering, and the administration of various drugs, — but without avail, for this incipient disease, although apparently relieved for a time, by such measures, invariably recurs, and the eye becomes irretrievably destroyed.

The hardness and over-distension of the eye-ball, suggested some means of relieving that condition, and accordingly, we find that the operation of tapping to evacuate the fluid contents of the eye, was practised by several surgeons, more especially by Windrop. — The internal inflammations of the eye, are, no doubt, frequently relieved by the evacuation of the fluid contents; but, in most cases, the relief is but transient and insufficient to arrest the progress of the disease.

Von Graefe directed his attention particularly to this subject, and first used hypodermics with the view of diminishing the pressure, but found that this measure was not attended by the slightest emolutive effect in Glaucoma.
He next tried the effect of repeated paracentesis of the anterior chamber, and this mode of treatment appeared to be successful in improving the vision and greatly relieving the urgent symptoms; unfortunately, however, the curative action was only temporary, and it was evident that this measure was insufficient. — The operation of "Irideotomy" had been practised in chronic iritis and irido-chorioiditis, and accordingly it was tried in glaucoma (by Graefe 1856) with the most satisfactory results. — It was found to have the effect of permanently diminishing the intra-ocular tension, and in many apparently hopeless cases of glaucoma, the urgent symptoms were not only relieved, but vision was restored. — Such being the results in Graefe's cases, other surgeons practised the operation of Irideotomy in glaucoma, and found that its effects were equally satisfactory.

Thus we owe to Von Graefe the discovery of that operation which is now acknowledged as the only certain means of curing that most dangerous disease — glaucoma.
As to the mode of action of Indirectomy, there has been much uncertainty; and the operation was strongly opposed by several surgeons in the country on account of this peculiarity regarding it. It was alleged by the opponents of Indirectomy, that as the precise indication accomplished by it could not be demonstrated, the operation was not to be adopted. But, nevertheless, the beneficial effect of Indirectomy could not be denied, and the operation was not to be rejected simply because its mode of action was, as yet, uncertain. We may account for the unsatisfactory results in some cases, by the fact that the diagnosis of glaucoma has been so uncertain: and it is possible that some operators may have imperfectly distinguished the conditions of disease to which they applied this remedy.

Indirectomy is performed in various directions, either upwards, outwards, or forwards: and any of these methods may be adopted according to character of the case. For this operation, it is essential that the patient should be perfectly steady, and therefore Chloroform should be
given, and the anæsthesia should be deep. —

The patient being upon his back, in a good light,
the next step is to introduce the speculum to keep
the lids open. — The surgeon, standing behind
his patient, seizes the conjunctiva with forceps,
at a small distance from the cornea, and at a
point opposite the intended incision. — The point
of the knife is then placed on the conjunctiva,
about a line from the cornial margin, and is
made to pierce the sclerotic, and to cut in the
anterior chamber immediately in front of the
iris. — It is pushed steadily onward, until the
incision attains the desired extent. It is then
gently withdrawn to allow of the gradual escape
of the aqueous humor. The operator then passes
the fine forceps into the anterior chamber, and
seizes the iris near the pupillary margin, at
a point nearly corresponding to the middle of
the section, cuts it through with scissors close to
the forceps, from the pupillary to the ciliary
margin, and then tears the piece still grasped
by the forceps away from its ciliary margin,
up to the angle of the wound, renders it
tense and cut it off close to the conjunctiva. - The cut extremities usually retract within the chamber.
If any portions of the iris remain within the lips of the wound, they must be displaced by the spatula, and the wound may be made to gape, in order partially to empty the chamber of blood. - The speculum being withdrawn, all coagula must be removed, not only from the wound, but also from the general surface of the conjunctiva. - The lids are then closed, covered by an elastic compress of cotton wool, retained by a bandage; and the patient is kept in bed. - An analgesia will usually be required; and by the third day the action will usually be healed. The aqueous humour again secreted, and the anterior chamber free from blood.

The effects of iridectomy are to diminish the intra-ocular tension, and to produce a change in the state of the ocular nutrition, so as to promote the resolution of inflammation. As the choroidal vessels communicate with those of the iris and ciliary processes, and as all these parts are extremely vascular, we may conclude that any operation which interferes with
The circulation of the iris, must materially affect the circulation of the others: - so that iridectomy acts beneficially in this manner by affording the best method of depleting the choroidal vessels.

By this operation, a free communication between the anterior and posterior chambers is permanently established; morbid products behind the iris are set free, and the full bleeding at once drains the engorged vessels of the choroid, and relieves the retina of pressure from behind. Such being the results of iridectomy, it is evident that the operation should be adopted in all cases of inflammatory glaucoma, and even when the disease has reached its later stage and the eye quite destroyed, still if there be great pain in the eye, we may relieve that pain by performing the operation.

I have observed the results of iridectomy in a large number of cases (at London Hospital, Bethlem Hospital) and I am quite convinced that the operation is the remedy for glaucoma.

In several cases of "glaucoma palpebrum" in which all the acute symptoms were rapidly
developed, have seen immediate relief follow the operation of Diodectomy.

The inflammatory spots of glaucoma, being confused with the other inflammations incidental to the eye, were formerly treated by bleeding, fusing, acciniy, opium to remedies which only palliate the symptoms. Diodectomy supersedes these severe measures in glaucoma, and as Dr. Bowman remarks, "Those who reject it have to explain whether they still employ unavailing remedies, or leave their patients practically untreated, and if these remedies be employed, whether they prove adequate now to arrest a disease against which they were formerly directed in vain". - Dr. Bowman adds, "Diodectomy is as effectual a remedy for glaucoma as is any remedy for any disease of which the tendency is progressively, up to the moment when the remedy is applied, to destroy the integrity of the tissues in which it occurs."

Diodectomy acts by permanently lessening undue tension, and thus allowing the oppressed organ to recover, so far as it has not already suffered change of structure.
under either long continuance of slight pressure, or great intensity of it for a shorter period.

As to the mode in which iridectomy permanently reduces pressure, we do not offer any explanation, but the fact remains that this operation controls a confidedly otherwise incurable disease, and their culpability is great who refuse their patients its benefit.

I cannot better illustrate the beneficial effects of iridectomy, than by inserting several cases recorded by Mr. Tulloch.

Case I. Acute Inflammatory glaucoma. - Second period. - A needlewoman, aged 30, whose mother had lost both eyes from glaucoma, was admitted into the Royal London Ophthalmic Hospital, January 20th, 1860, with acute inflammatory glaucoma of her right and only eye. (The left eye had been accidentally injured in a squint operation fourteen years before, and was atrophied.) The eye ball was very hard, much congested, and painful; the pupil was dilated, and almost motionless. A beginning of the hemorrhages prevented an accurate exploration.
of the fundus oculi; but the retinal veins were turgid and there was slight excavation of the optic disc. The field of vision was much contracted, particularly below, and her vision was so blunted that she could not make out Ke 30 text type (eight-line Roman), the short letters of which are seven-eighths of an inch tall. For two years, she had been liable to occasional obscurations and a rainbow round the candle-flame. Sheformed iridectomy, removing the upper and outer seventh part of the iris.

January 24th. The congestion was less. The tension of the globe natural. She read the smallest type on her bed ticket (about Ke 10 test). Jan. 31st. The redness of the eyeball was gone. Her sight was improving. She was made an out-patient. Feb. 10th. The tension continued natural. She read Ke 2.

Feb. 19th. She read Ke 1 (brilliant). icy. She read Ke 2 and was supporting herself by needleworth.

The optic disc was no longer excavated.

Case II. - Acute Inflammatory Glaucoma.

A severe, very old sailor aged 66 who "had never known a day's illness", was attacked with severe pain in the right eyeball, which became veiled.
the pupil dilated and motility lost. The cornea so dull that the ophthalmoscope could not be used: the field of vision much contracted; at its centre, he could just make out letters in 20/20 test type. There was constant severe pain, not as violent as at first, but progressively aggravated. I performed iridectomy.

On the third (three days afterwards), the hardness had much diminished, but not quite disappeared. He had corneal, but the former severe pain was gone. The cornea was brighter; the redness was fading. He had no pain. His sight was improving. The ocular tension was normal. He read 4/16 quickly.

22nd - The tension continued normal. With convex spectacle of 20 inches focal distance (to correct his presbyopia), he read 4/6.

26th - He continued as at the last date. He was now obliged to leave with his ship, so I would have iridectomised his left eye which began to exhibit precocious symptoms of glaucoma.

Case III. - Subacute inflammatory glaucoma of the right eye. Second stage. Iridectomy. An anterior was seized with pain in the right eye, which lasted continuously with great
severity for two days, and then became remittent.

The sight became very dim. Three weeks after
this, he came under my care at the Royal London
Ophthalmic Hospital. The eyeball was hard;
the pupil large and motionless; the cornea dull,
its surface uneven, its sensitiveness much blunted.
The anterioriliary veins were swollen. He made
out letters in 4/20 test type, and counted fingers
at four feet. The inner half of the field of vision
was much contracted. March 1st. Sphincter was
performed. 5th. He had no pain; the redness
was subsiding. He read 4/10. June 28. He
read 4/10 with spectacles. There was no pain
now redness.

The cases quoted above are sufficiently illustra-
tive of the results of sphincter, and I shall
add another case which is typical in its symp-
toms and results (reported by W. Wilcox).

Miss F., female, set. 50. Her right eye was com-
pletely lost from repeated attacks of glaucoma,
while she was in Illinois U.S. — came to England
to see if she could obtain any relief for this eye,
Has in it frequent attacks of acute pain.

Left eye was quite comfortable until yesterday. Never had obstructions or other premonitory signs. She never suffered from gout or rheumatism. Yesterday about 2 p.m. while at dinner, she had sudden acute pain in the eye, lachrymation and redness. Everything in the room appeared enveloped in smoke. The eyeball felt swollen. Great pain in the nose, cheek, around orbit and back of head. She became very sick and vomited much. She had no relief until she came to the hospital (Woodfields) at 12:30 p.m.

Present state. She is a thin, weak woman, quite prostrate with pain, and very sick. Left eye chemosec. Lachrymation, cannot raise upper lid. Cornea dull. Iris pressed forward. Pupil slightly dilated and motionless. Cannot read largest print.

set 6 - Indecision was performed on the left eye; the right was excised.

set 4 - Relief followed the operation immediately. She slept quite comfortably, better than usual. Has had no sickness or pain since the operation.

I have endeavored to illustrate by the cases detailed, the beneficial results of lenticlectomy; and, indeed, the most conclusive evidence regarding the value of the operation, is to be derived from this source.

— Louis —