GLAUCOMA,

AND ITS

SURGICAL TREATMENT BY IRIDECTOMY.

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IN December, 1857, I laid before this Society an account of some points in the morbid anatomy and pathology of glaucoma, drawn from dissections of eyes made directly after their extirpation, and whilst perfectly fresh. In the discussion which arose upon this communication, mention was made of the treatment of glaucoma by "Iridectomy," an operation first practised by Graefe in chronic irido-choroiditis with posterior synechiæ, and subsequently adopted by him with remarkable success in the treatment of glaucoma. In the following spring, I contributed to the 'Medical Times and Gazette' a short notice of Graefe's operation, which had been tried upon several patients in the Royal London Ophthalmic Hospital, and which already, at that time, promised most satisfactory results. Since then, iridectomy has been very extensively practised in cases of glaucoma by some of my colleagues (of whom I would especially mention Messrs. Bowman and Critchett) and by myself, with a success which has entirely assured us of the great value of the operation. In England generally, however, it has hitherto met with much opposition, and has

gained but few advocates beyond those connected with the hospital where it was first practised: it must therefore, in the absence of a general recognition of its beneficial effects in glaucoma, be considered, in this country, as still upon trial.

Being convinced by the accumulated experience of many cases, during the past two years, of the curability of glaucoma by iridectomy, and feeling persuaded that this treatment only requires a fair and impartial trial to secure its general adoption, I am desirous of bringing it under the notice of this Society. Of the several objections which have from time to time appeared in the journals against it, the principal one is its alleged uniform failure, even in the hands of very experienced surgeons. I can only attribute this to its having been applied to cases that were not true examples of glaucoma; an occurrence rendered highly probable by the absence of a general agreement respecting the nature, symptoms, &c., of this disease. On this account, in order to prevent any misunderstanding respecting the nature of the cases in which I advocate the performance of iridectomy, I shall preface my remarks on the operation with an outline of glaucoma, referring those who desire a more detailed account to Graefe's masterly and comprehensive papers in the '*Archiv für Ophthalmologie*.'

Glaucoma occurs in two forms, an acute and a chronic, which differ mainly in the relative duration and intensity of their symptoms, whilst their affinity is rendered evident by community of structural changes, by a common termination, and by the fact that chronic glaucoma sometimes passes into acute. There is also a third class of cases occupying an intermediate position.

Prodroma.

In 75 per cent. or more of all the cases, the active stage of the disease is preceded by a premonitory period—"*Prodroma*." The transition from this to the active period is sudden and marked in acute, whilst it occurs by insensible

gradations in chronic glaucoma. As it is a disease almost peculiar to mid-life and old age, its subjects are for the most part presbyopic ; but a rapidly increasing presbyopia is always suspicious, and often foreshadows glaucoma. The appearance of a rainbow round the flame of a candle, occasional spontaneous flashes, and other luminous spectra, are early symptoms of common occurrence. At this time, too, an occasional dimness of vision is noticed, often towards the close of day, or under the influence of excitement, and this is associated with vague pain in the eye and about the brow and temple. The pupil is rather large and sluggish ; the iris and lens are pushed slightly forwards, and the size of the anterior chamber is diminished. A slight hardness of the globe, indicating increased tension, may generally now be detected by careful palpation. The duration of these premonitory symptoms is very variable ; it may be restricted to a few days, or may extend over weeks, months, or even two or three years. Their intensity also varies greatly, and they are frequently so slight that they do not excite serious apprehension ; indeed this happens commonly amongst the poor and labouring classes.

Acute Glaucoma.

In acute glaucoma, the prodromal symptoms are generally followed by a sudden attack of violent pain in the eyeball, with rapid extinction of sight, often attended with sickness. The pupil is widely dilated and motionless, and it sometimes has that peculiar greenish tint which was formerly considered so characteristic of glaucoma. The ciliary region and the conjunctiva are red, and the latter is often slightly chemosed. The globe is very hard. The cornea is dull, and its sensibility is diminished. After a variable time, a remission takes place : the eyeball becomes less hard, the pain abates, the redness subsides, and sight returns. This, however, is not a cessation of the disease, and the temporary improvement is sure to be followed by fresh paroxysms, which sooner or later invariably end in complete blindness.

The eyeball remains hard and painful for a long time after sight is extinct, and sclerotic staphylomata frequently form ; a very common situation for them being just behind the insertions of the tendons of the musculi recti, where the coat is naturally thinnest and least resistant.

Chronic Glaucoma.

In chronic glaucoma the premonitory gradually slides into the active period. The obscurations and pain, at first evanescent and separated by long and complete intermissions, become more frequent and last longer, until at length they are never wholly absent. The globe becomes harder. The area of the field of vision decreases. The aqueous humour becomes slightly clouded ; the pupil is dilated, and sometimes adherent to the capsule of the lens ; the iris is dull, and enlarged veinlets may often be seen upon it. The lens, pushed forwards by excessive pressure from behind, closely approaches the cornea, lessening the size of the anterior chamber, which is also encroached on laterally by the iris, distended with fluid which has accumulated in the posterior chamber. The sclerotic assumes a waxy, leaden hue. In the ciliary region, the distended efferent veinlets encircle the cornea with arches, and send backwards varicose trunks. The conjunctiva becomes atrophied, and is readily torn. The cornea is dull, its convexity decreases, its epithelium is raised in minute vesicles, and its sensitiveness is greatly impaired. By this time vision is reduced to a slight quantitative perception of light, or is wholly extinct. At this stage it cannot always be determined from the appearance of the eyeball whether the disease had originally an acute or chronic type, but I have observed that sclerotic staphylomata are more common in the originally acute cases.

I would call particular attention to the flattening of the cornea in glaucoma ; because a statement has recently appeared that the cornea acquires increased prominence, becoming, in fact, conical in this disease. Its flattening may be readily demonstrated, as Graefe observes, by com-

paring the image which the flame of a candle forms upon the cornea of the glaucomatous eye with that formed on the cornea of the sound eye. It has been experimentally shown that excessive distension of the eyeball lessens the curvature of the cornea, and no doubt the flattening in glaucoma is due to this cause.

Ophthalmoscopic Signs.

Excavation of the optic nerve-entrance and pulsation of the arteria centralis retinæ are pathognomonic of glaucoma. Small dotted hæmorrhages in the retina are of frequent occurrence, and are occasionally associated with delicate filmy blood-clots in the vitreous humour. The excavation of the optic nerve-entrance is indicated by a bluish-gray colour of its periphery, and by a peculiar arrangement of the veins. Where the excavation is slight, they undergo a sudden diminution of calibre at the margin, being smaller within the limits of the nerve-entrance than on the adjacent fundus; but where the hollow is deeper, the veins are abruptly bent, or their continuity is apparently interrupted, at the spot just mentioned. The excavation, though partly the direct mechanical effect of the excessive tension of the eyeball, is mainly a secondary consequence of it: the excavation is begun by compression of the soft, yielding nerve-substance, and afterwards increased by its atrophy.

In extreme excavation the bottom of the hollow lies outside the level of the choroidal foramen, and is formed by the lamina cribrosa, covered by the detritus of the wasted nerve-fibres. I have recently dissected an eyeball in which the lamina cribrosa itself was pushed outwards; in this case the excavation was very deep. The bluish colour of the nerve-entrance is the combined effect of shadow, and the peculiar reflection given by the fibrous tissues and fatty granular remains of the nerve. The spontaneous pulsation of the retinal vessels is another effect of excessive intra-ocular pressure. A less degree of pressure suffices to produce the venous than the arterial pulse; and it was

shown long ago that both may be artificially produced in the healthy eye by compressing it with the finger.

The retinal hæmorrhages come from ruptured capillaries which have become varicose and sacculated from over-distension. I have already described this condition of the capillaries in a former paper. Very erroneous opinions have prevailed respecting the state of the vitreous humour; by many it was supposed to be fluid—a misconception that has given rise to futile plans of treatment. In acute and in chronic glaucoma, the vitreous humour continues, for a long time, much firmer than natural. In several eyes which I have dissected at an early period of the disease, I have been much struck with the remarkable consistence of this humour, and I have verified the existence of the same condition in the living eye by puncturing the sclerotic freely with an extraction-knife, and then endeavouring to squeeze out some of it. That a *dissolved* state of this humour is an *essential part* of glaucoma, is wholly opposed to my experience. It is only in old cases, where the disease has run its course, and when the retina, the choroid, and all the other tissues of the globe are involved in a common atrophy, that the vitreous humour becomes diffuent; and I believe that those dissections in which it has been found fluid must have been made at this late period. In a recent dissection of acute glaucoma, I found a thin stratum of yellow serum between the hyaloid capsule of the vitreous humour and the membrana limitans of the retina. I had previously suspected the possibility of such an occurrence from ophthalmoscopic observations on the living eye.

The Nature and Causes of the Glaucomatous process.

All the prominent symptoms—the hardness of the globe, the peculiar progressive contraction of the field of vision, the paralysed dilated pupil, the intense throbbing pain, the excavation of the optic nerve-entrance, the pulsation of the retinal vessels—are, one and all, consequences of excessive intra-ocular pressure, and this is due to an increase of the

vitreous humour, both as regards quantity and firmness. In a very typical case of acute glaucoma, I found, upon dissection, the hollow of a large sclerotic staphyloma, beneath the tendon of the musculus rectus externus, wholly filled with very firm vitreous humour, in no way differing from the remainder. Since the vitreous humour draws its nourishment from the vascular tunics, any increase of it must depend on some disturbance of the process of nutrition in these parts; and there are good grounds for believing that a congested or inflammatory condition of the choroid is the first step. Graefe considers "acute glaucoma" to be a serous choroiditis, and I am disposed to adopt his view. Although I have not so frequently verified, with the ophthalmoscope, the presence of choroidal hæmorrhages in the living eye in glaucoma as he has done, and have only exceptionally observed them in dissections, I have often ascertained, by actual measurement, that a considerable dilatation of the larger veins exists, and of the choroidal capillaries. Probably the retina is only passively concerned. The calibre of its arteries is scarcely enlarged, the arterial walls become hypertrophied; but this and the venous and capillary hyperæmia seem to be due to obstruction of the efflux of blood at the optic nerve-entrance. The occasional outbreak of glaucomatous inflammation in amaurotic eyes, where the retina has long been atrophied, also shows that this tunic plays no essential part in the disease. I cannot pass without notice an ingenious theory of glaucoma which Mr. Hancock has recently propounded. He attributes the pain, the ophthalmoscopic signs, and the pathological appearances, to a spasmodic contraction of the ciliary muscle (analogous to spasm of the urethral muscles and sphincter ani) compressing the ciliary nerves, and obstructing the circulation. He has observed, in acute glaucoma, a circular depression, externally, corresponding to the ciliary muscle, and an elongation of the antero-posterior diameter of the eyeball, with conicity of the cornea, which he also ascribes to the same muscular spasm.

It is obvious that the cases in which Mr. Hancock saw

these features cannot have been examples of glaucoma, such as I have described it ; because, as I have stated, the cornea is flattened, and not conical. Allowing, however, that a spasm did exist, the contractility of the muscle would soon become exhausted by the continuous tension to which it is subjected. But the most complete proof that the spasm of the ciliary muscle is not an essential part of glaucoma is afforded by the coexistence of a hard, painful, glaucomatous state of the eyeball, with advanced atrophy, and fatty degeneration of the muscle, a fact which I have several times verified by dissection. Assuming it to be highly probable that the glaucomatous process begins as hyperæmia or inflammation of the choroid, the question next arises, to what is this due ? It has long been customary to connect glaucoma with gout, but, as it appears to me, without sufficient evidence. A very large number of cases occur in women, without gouty history or hereditary tendency, and very many of its male subjects do not present any trace of the gouty diathesis. Atheroma of the vascular system has been assigned as another cause ; and, inasmuch as glaucoma generally attacks persons of or beyond middle age, an earthy, rigid state of the arteries is often present : but I have so constantly failed to discover any degeneration of the vessels of the eye in typical cases of glaucoma, at an early period, that I am persuaded the two diseases do not stand in the relation of cause and effect. I have endeavoured to ascertain whether kidney disease, with albuminuria or diabetes, have any immediate connection with glaucoma, but with negative results ; yet kidney disease and retinal apoplexy are frequently associated. At present we only know, that a certain period of life, an enfeebled constitution, prolonged mental anxiety, and broken rest, predispose to its occurrence. Some injuries and diseases of the eyeball occasionally lead to a glaucomatous condition. Penetrating wounds of the ciliary region, injuring the lens, are prone to do so, as I have seen in several instances. The same fact had been remarked by Graefe, who had also noticed its occasional occurrence in advanced sclerotico-choroidal staphyloma and chronic

irido-choroiditis. I have also observed this, and I have verified by dissection the presence of a hollowed optic nerve-entrance in advanced posterior staphyloma.

Prognosis.

Blindness is the natural issue of glaucoma.

Treatment.

The age and broken constitution of the subjects of glaucoma usually forbid general depletion. Venesection is inadmissible; and I have never seen mercury or aconite, though freely administered, cure a single case. Leeching and blistering are occasionally useful auxiliary measures; but alone they are quite incompetent to cope with the disease.

The over-tension of the eyeball naturally suggests the evacuation of some of the superabundant fluid by tapping, an operation with which some of the older surgeons, Antonius Nuck, Riverius, Jobus à Meekren, and others, were familiar; but they appear to have chiefly practised it in onyx, hypopion, and hydrophthalmos. Wardrop, whose observations are contained in the fourth volume of our 'Transactions' (1813), first gave it an extensive trial, and attempted to define the cases in which it was likely to prove useful. With the object of lessening fulness and congestion, he punctured the cornea in superficial, and in deep-seated inflammations of the eyeball. Other surgeons, stimulated by his successes, warmly took up the operation, but the want of uniformity in its results soon led to its being abandoned. In our own day, paracentesis oculi has been warmly advocated by Desmarres in internal inflammation, and some other diseases of the eye; Mr. W. Martin, late Superintendent of the Calcutta Eye Infirmary, also speaks highly of its curative action in fulness of the globe, with pain of a "tensive" character; but amongst English surgeons it has found little favour, though most have occasionally performed it. In some affections the evacuation of the

aqueous humour through a puncture in the cornea is a measure of extreme value, and in glaucoma also it affords relief; but this is very transient and incomplete, it does not arrest the course of the disease. Paracentesis of the sclerotic is practised by Desmarres and Hancock, though with different objects, and in different ways; as it has been proposed as a substitute for "Iridectomy," I shall revert to it after considering Graefe's operation.

The limits of this paper do not allow me to notice the various steps by which Graefe arrived at this plan of treatment. The operation consists in excising a segment of the iris, in its whole breadth, from the pupillary edge to its insertion. This is effected through an opening of corresponding size at the extreme margin of the anterior chamber. He introduces the point of a lance-shaped knife through the sclerotic, at about half a line behind the margin of the cornea, and gives it such a direction that it appears in the anterior chamber, just in front of the insertion of the iris, when, by pushing it onwards towards the centre of the chamber, an incision of sufficient size is obtained. Usually, as I understand, he makes an inward iridectomy; but he does not insist on any particular situation; and he says that when desirable, for the sake of appearance, it may be made upwards. The latter situation is that chosen by Mr. Bowman, who first introduced the operation into this country, and has slightly modified some of its details. This modified operation is the one which has been mostly practised in the Royal London Ophthalmic Hospital, and that which I am accustomed to perform. Instead of the lance-shaped knife I have preferred to use an ordinary extraction-knife, as being generally safer. In consequence of the diminished size of the anterior chamber, the incision must be made with care; for if the chamber be opened by a puncture that is afterwards enlarged by a sawing movement, the aqueous humour will probably escape, and the point of the knife may catch the iris, or prick the lens before the incision is completed. The knife, therefore, once inserted, should be pushed steadily

onwards across the margin of the chamber, so as to cut its way out at a short distance from the point of entry, ere the escape of the aqueous humour allows the iris to fall on its point or edge. By skirting the margin of the anterior chamber in this manner, the point of the knife is always at a distance from the prominent centre of the lens (which, it must be remembered, closely approaches the cornea in this disease), and there is no danger of wounding it, an accident which I have seen happen several times when the lance-knife has been used. In completing the incision, as the aqueous humour escapes, the iris slightly protrudes through the lips of the wound. It should be gently drawn out with a forceps, and cut off with scissors at each angle of the wound; as this is being done, a drop of yellow serum usually gushes from behind the distended iris. The result is, that the pupil is at once enlarged, up to the incision, which forms, as it were, the base of a coloboma iridis; and the edge of the lens, with the suspensory ligament stretching in front of the vitreous humour, and the ciliary processes, are exposed to view. A little blood oozes into the anterior chamber, from the cut edges of the iris, or from the rupture of enlarged vessels upon its surface. It is well to remove this at once, either by gentle pressure on the cornea, with the smooth back of a scoop, or, if this fail, by passing the instrument into the chamber, through the incision. Should a little delay happen, and the blood have become clotted, it is not readily got away, and may be left to undergo absorption.

The after-treatment is of the simplest kind. Graefe, for a short time after this operation, fastens a light compress upon the eye with an elastic woollen bandage, as a precaution against hæmorrhage. I have sometimes adopted this measure, and have always had reason to be satisfied with it; but I more commonly substitute a piece of wet rag for it. During the next few hours after the operation, the aqueous humour drains away, but the incision soon closes, and the anterior chamber re-fills. The extreme hardness of the eyeball is at once lessened, and a natural tension is gradually

assumed. The pain generally at once abates, and soon altogether ceases. As regards vision, my experience is entirely confirmatory of Graefe's, that the ultimate results of iridectomy are intimately dependent on the period at which it has been performed, the restoration being more complete where it has been early undertaken than where it has been postponed.

In the premonitory period, there can be no doubt of the propriety of operating where the intercurrent obscurations, the contraction of the visual field, and the ciliary pain are marked and increasing; and patients will gladly submit to it, if the known undeviating course of the disease be explained to them. I have operated at this period with entire success, arresting the disease, and, as it were, forestalling the impending inflammatory attack. Where the symptoms are slight, and the intermissions long and complete, delay is less dangerous.

In acute glaucoma, I have several times operated at a very early period, during the first paroxysm of violent inflammation, and have obtained most brilliant results. The inflammation has subsided, the eyeball has acquired a natural tension, the humours have cleared, and vision has been very completely restored. I have had patients, who previously to the operation had only a feeble quantitative perception of light, and were wholly unable to recognise the largest objects, who have become again able to read and do needlework.

Some amelioration generally takes place within a few hours or during the next day or two; but the full extent of improvement is not attained till several weeks or months have elapsed. In some instances, the iris regains its brightness and contractility, but it more usually remains motionless. The ophthalmoscope shows a gradual disappearance of the retinal hæmorrhages, an absence of pulsation in the retinal vessels, and, where the operation has been done at an early period before wasting of the nerve, a normal state of the optic-nerve-entrance. In cases such as these, the blindness was due to excessive pressure on the retina, and disappeared on its removal. Graefe predicts

complete restoration of vision where moderate quantitative perception of light exists, and the operation is performed before the expiration of a fortnight from the date of the first inflammatory attack. In older cases, the inflammation is subdued by iridectomy, but the improvement of vision is not so complete, its degree depending on the previous progress of the atrophy of the optic nerve and retina. Where the excavation of the nerve-entrance is slight, and where it has not the shining, glistening reflection peculiar to advanced atrophy, it diminishes after iridectomy, as Graefe has shown, and as I have also observed; and I think that it sometimes wholly disappears. The degree of atrophy does not entirely depend on the amount of time which has elapsed since the first outbreak of inflammation, but also on the severity, or comparative mildness of the latter. The less contracted the field of vision, the more favorable the prognosis; yet very successful cases now and then occur, where the area has been previously greatly diminished. In one of my best cases, the day before the acute attack, the visual field, measured at the distance of eighteen inches, was elliptical, the long axis being horizontal; the diameters were nearly three by three-and-a-half inches respectively. In older cases, so long as there is a fair quantitative perception of light, some improvement may be expected. I have realised this, even where I have operated seven and eight months after the date of the first attack.

In chronic, the results of iridectomy are less uniform and less decided, than in acute glaucoma. It is a more insidious disease, and the structural changes creep on simultaneously with the gradual increase of pressure and diminution of sight. Just as happens in the acute form, the earlier the iridectomy, the greater the improvement of vision; but where no improvement takes place, the disease is arrested, and the existing degree of sight is preserved. More rarely, the amelioration is temporary, the globe remains of a natural tension, and the former pain does not recur, but atrophy progresses, and with it sight becomes extinguished. In old cases, where the disease has run its course and sight has long been

lost, the pain has generally been relieved ; but in a few cases it has either persisted or returned, and excision of the globe has been necessary.

I shall not here indulge in any speculations respecting the manner in which iridectomy reduces the excessive tension of the eyeball, which is the prominent feature of glaucoma : that it does so, is an established fact which, like many others, we may accept empirically until its *modus operandi* is elucidated by further experience, and a more perfect acquaintance with all the details of the disease.

Alleged objections to Iridectomy.

The alleged uniform failure of iridectomy, in the hands of some surgeons, is, as I have already hinted, with great probability, to be generally attributed to its having been practised in cases which were not examples of glaucoma at all. Other failures have, as I know, proceeded from it having been done in very old cases at far too late a period, when the disease had run its course and the eyeball was disorganized. It has been also said that iridectomy is far too difficult an operation to be generally practised ; but its difficulties have been greatly overrated, and I believe that it does not require more skill and manual aptitude than most surgeons possess. When chloroform is used, it really becomes a simple and easy operation ; but even supposing it were a difficult one, which it really is not, in the absence of other known means of cure, we should be no more justified in rejecting it on this ground, than we should be in refusing to operate on a strangulated hernia where all other measures had failed. The disfigurement produced by the gap in the iris is too trivial to form a real objection ; besides, it may be avoided by forming it under cover of the upper eyelid. The loss of accommodation has been adduced as an objection, but more recent experience has corrected some erroneous impressions which formerly prevailed on this subject.

It is now ascertained that the previously existing pres-

byopia is not increased by the removal of a portion of the iris ; indeed, the refractive power of the globe sometimes actually increases ; probably, as Graefe says, in consequence of the flattened cornea resuming a natural convexity.

In order to avoid these alleged disadvantages, paracentesis of the sclerotic has been advocated by Mr. Middlemore and M. Desmarres, as a substitute for iridectomy. The former proposes to evacuate the *turbid diffuent* vitreous humour with a grooved needle, and to replace it with a syringe full of clear water. But the vitreous humour is much too firm to flow out along the groove of a needle, and few English surgeons would, I imagine, adopt Desmarres' plan of introducing a probe and stirring it up. Mr. Hancock, assuming a spasm of the ciliary muscle to be the essence of glaucoma, divides this structure by passing a knife through the junction of the cornea, and the sclerotic and ciliary region, backwards and inwards towards the axis of the globe. In doing this, the margin of the anterior chamber is opened, the aqueous humour escapes, and the vitreous humour is tapped. Having demonstrated that the ciliary muscle is not concerned in maintaining the glaucomatous condition, I am inclined to ascribe Mr. Hancock's reported success solely to the paracentesis : if this surmise be correct, his operation cannot rank as a substitute for iridectomy, until it has been thoroughly established that it permanently relieves excessive intra-ocular tension, which I have found paracentesis of the vitreous humour fail to accomplish.