(c) Injury by striking the eye on some object, as in the present case.

The chief points of interest are:—

1. The mechanism of the injury, and non-rupture of the ocular muscles.
2. The anaemia of the fundus, presumably due to stretching of the optic nerve and contained artery, and complete recovery of vision after three quarters of an hour's luxation.
3. Comparative lack of pain throughout.
4. Absence of signs in the fundus.
5. Response of the inflammation of Tenon's capsule to M. and B. 693 and diathermy.

We are indebted to Mr. Humphrey Neame for permission to publish the case.

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CYCLODIATHERMYPUNCTURE IN CASES OF GLAUCOMA*

BY

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IT is now three years since I and my assistants first made use of the C.D.P. (diathermypunctures of the ciliary body) against glaucoma so that I now feel it essential to describe this operation to my colleagues as well as to recommend it to them as a valuable antiglaucoma-operation.

Three years ago when I described the operation for the first time (*Schweiz. med. Wochenschr.*, 1936, p. 593, and *Swiss Ophthal. Soc.*, Geneva, June 4, 1936, published in the *Klin. Monatsbl. f. Augenheilk.*, Vol. C., p. 672) I not only stressed its advantages, but especially pointed out its dangers.

These dangers, which I described fully (*Klin. Monatsbl. f. Augenheilk.*, Vol. XCIX., July 9, 1937), we succeeded in reducing and eventually avoiding during these three years, so I believe

* Translated from the German by Mrs. Helen F. Sieger-Bechtler, and Dr. med. G. Gerhart Meyer.

that I can now safely recommend to all my operating colleagues the method of C.D.P. in the fight against the most destructive of all eye-diseases.

When is the C.D.P. indicated, and when not?

I consider it a matter of course that in cases of acute primary glaucoma the classic iridectomy of von Graefe should, if possible, be used. The method as described by Graefe is the best, but if the anterior chamber is very shallow the iridectomia tangentialis (Salzmann, Vogt, vide *Monatsbl. f. Augenheilk.*, Vol. C., p. 131, 1938) is preferable. I have not hitherto made use of the C.D.P. in such cases of glaucoma.

When a chronic primary glaucoma has to be operated on the situation is different. The C.D.P. can here seriously compete with the methods aiming at subconjunctival filtration, *i.e.*, with trephining after Elliot, with the sclerectomy of Lagrange or the iridencleisis of Holth. For the C.D.P. does not involve the danger of all those methods with subconjunctival filtration, viz., secondary infection which may result in acute panophthalmitis or even in sympathetic ophthalmitis especially frequent after trephining and iris inclusion. Sympathetic ophthalmitis has so far never been observed after C.D.P., nor has it ever been found in other methods of ignipuncture of the eye. (We must remember that for 60 years punctures with the electric needle (de Wecker, Abadie, 1881) and the Paquélin have been employed for countless perforations of the uveal tract (detachment of the retina). These have never resulted in sympathetic ophthalmitis).

The C.D.P. has been performed hundreds of times and has never shown such after effects. Obviously because the method produces scars of the sclera which do not permit a secondary infection. Probably also because the needle has a temperature of over 1,000° centigrades.

To be on the safe side we have hitherto confined the C.D.P. to those severe cases where iridectomy and other methods with subconjunctival filtration had failed. Every ophthalmologist has at times found himself at a loss to combat certain malignant forms of glaucoma. Especially in these cases the C.D.P. can be of great use.

The C.D.P. has been of great service to us in all those cases where, owing to high tension the anterior chamber had disappeared, either after an ineffectual iridectomy or after trephining. Miotics are of no use in these cases. The lens and the iris remain pressed against the cornea and the surgeon can do nothing but watch his patient go blind. No operation from iridectomy up to cyclodialysis and sclerotomy had until now been possible without the existence of a chamber. In these cases the C.D.P. is the saving operation. Its technique is even in such desperate cases

a *simple* one and the surprising result can already be seen on the following day by the forming of a deep or medium deep chamber, provided always that the case was not of too long a standing. After this result of the C.D.P. any other of the intra-ocular operations from iridectomy to extraction is again possible.

This result alone justifies the discovery of the C.D.P. and to-day I deeply regret that I did not know of it earlier for such desperate cases.

When is the C.D.P. indicated in cases of secondary glaucoma? Whenever a simple iridectomy is not sufficient. There are malignant cases of acute iritis followed by severest secondary glaucoma when iridectomy only causes a haemorrhage in the shallow chamber but not even a temporary lowering of the high tension. The eye remains hard with hardly an anterior chamber. I lost a similar case where both eyes were affected 10 years ago. To-day I would under similar circumstances use the C.D.P. and probably with better results.

Iritis itself as far as I can tell from my comparatively few cases has not been unfavourably influenced by the C.D.P. An eighty year old patient had undergone trephining on account of primary glaucoma. After some months a subacute iritis was observed and the other eye, likewise affected by glaucoma, showed deposits and an opacity of the anterior chamber. Sympathetic ophthalmitis was of course suspected. The C.D.P. brought back not only a normal tension but the deposits disappeared and never returned during the 18 months that I could follow the case.

Another example. A thirty-two year old lady had high tension in both eyes with numerous deposits. In spite of an apparently correctly performed trephining combined with iridectomy on the left eye glaucoma absolutum followed. The same fate threatened the right eye after I had in vain performed the same operation on it. The tension rose to 50-60 mm. Hg in spite of all miotics. The first C.D.P. operation made from above reduced the tension for a couple of months to subnormal and normal values and the deposits diminished. But afterwards the tension rose again to 40-50 mm. Hg although miotics were freely applied. The second C.D.P. was performed from below. It brought about a longer and better reduction of the tension of the eye. After four months a third operation on the temporal part of the sclera became necessary. The tension is now normal. In the meantime the deposits had not entirely disappeared but they had at least considerably diminished. (There were no nodules on the iris, no signs of a tubercular affection and the blood Wassermann was negative.)

It appears therefore that iritis is influenced not unfavourably by the C.D.P. and it is no contra-indication.

The question arises whether the method is suitable to bring back

to normal tension the hitherto intractable cases of glaucoma haemorrhagicum, for instance after obstruction of the central retinal vein. From my experience the C.D.P. can be attempted without any danger in this form of glaucoma. Extensively employed, it now and then gives permanent success and makes an enucleation avoidable, but in my cases failures have been in the majority. It must be remembered that in these cases this operation can be repeated on the same eye sevéral times. Before operating a careful examination with the slit-lamp should never be omitted. One will thus frequently find signs of iritis and deposits on the cornea for which one might have, without this examination, blamed the operation.

The special character of this form of glaucoma which begins with a disturbance in the posterior part of the eye can sometimes be proved by giving atropine and hyoscine as I did in a certain number of cases which had become blind and were destined for enucleation. In some cases these mydriatics lowered the tension considerably instead of raising it as should have been expected. At the same time the patients were relieved of their pains.

How can the dangers of this new method which I described in the above-mentioned papers of 1936 and 1937 be avoided?

The cornea and the lens are of course in more danger of being injured than the iris, the vitreous, or the retina.

As far as the cornea is concerned a keratitis, a necrosis, or a permanent blurring may follow when operating too near to the limbus. The operator who approaches the limbus corneae with his diathermy-needle closer than two and a half mm. runs the risk of damaging the cornea. These injuries may consist of blurrings which may become vascularised, eventually even in ulcers and necrosis. In these cases conjunctival plastic operations give very bad results.

The possibility of damaging the lens and starting a cataract is the greater in proportion to the length and thickness of the needle employed. The needle must under no circumstances be longer than 0·5 mm. from its point to the stop unless the lens is missing or is completely opaque. In aphakic cases the needle can exceptionally be 1 mm. long.

Too thick needles increase the danger of haemorrhages. The needles with a stop which I had made for me by Grieshaber (Schaffhausen) have a thickness of 0·15 to 0·18 mm.

With needles of this length and thickness damage to the lens is unlikely. I have had no experience, however, with those rarer forms of glaucoma in which an abnormally large and thick lens touches the ciliary body with its equator to the extent of even compressing it. But even in these cases a 0·5 mm. needle will not be able to cause a traumatic cataract because the sclera and the

ciliary body together are considerably thicker measuring according to Salzmann 0·8 mm. at their thickest point. As a result of these important anatomical facts it follows that one must not operate without a stop.

The iris can be endangered on the one hand by a haemorrhage which may take place 8-14 days after the operation, and on the other hand by exudative iritis. The danger of this is lessened in proportion to the fineness of the needle employed and the further away one keeps from the limbus corneae. In the last year and a half I have not had any cases of haemorrhage or severe iritis because, as a matter of fact, at a certain distance from the limbus one does not touch the root of the iris.

A hyperaemic iris and an increased opaqueness of the anterior chamber follow as a rule one or two days after the operation. A slight exudation is not infrequent.

It is important to set a slight lesion of the vitreous without injuring it too much.

A small loss of vitreous is not only unavoidable but it is even desirable that a little vitreous fluid trickles out. The punctures are very numerous but as a rule so minute that only a watery fluid oozes out and not real consistent vitreous. Larger losses can only occur if the punctures are so numerous as to become confluent. Practically one can reckon that only the smallest loss of vitreous takes place and this is of therapeutic value. It means a relief for the lens especially where an enlarged vitreous presses it forward sometimes even against the cornea. The further away we operate from the limbus the greater is the loss of vitreous to be anticipated.

We have never met with a detachment of the retina as a result of this minute loss of vitreous. However, we must always be careful to keep this loss within the smallest possible limit.

It is perfectly right that a C.D.P. which begins only $2\frac{1}{2}$ mm. from the limbus and reaches to about 4-5 mm. behind lies for the greater part back of the ciliary body and includes more the orbiculus ciliaris up to the ora serrata. According to the excellent measurements of Hans Wagner as well as of former authors the anterior border of the retina, *i.e.*, the ora serrata reaches in the case of an emmetropic eye on the average nasally to 5-7 mm. behind the limbus corneae, temporally, above and below to 6-$7\frac{1}{2}$ mm. In the myopic eye with its long axis the distance is greater than in the emmetropic and hyperopic eye.

Against this argument may be said that purely from the anatomical point of view the ciliary body and the pars plana form an entity. An authoritative expert on this part of the eye such as Maximilian Salzmann, said in his work "Anatomie und Histologie des menschlichen Augapfels" (Leipzig and Vienna),

1912, p. 116, that the ciliary body forms a girdle which is narrower on the nasal side and above (4·66-5·2 mm.) and broader on the temporal side and below (5·6-6·3 mm.). Salzmann believes that the corona ciliaris (anterior part) and the orbiculus ciliaris, that means the whole girdle from the root of the iris backwards to the ora serrata (anterior part of the retina), form the ciliary body. (Fig. 1.)

Thus the zone of our operations reaches dorsally as far as the orbiculus ciliaris, *i.e.*, the pars plana corporis ciliaris and even into the neighbourhood of the retina.

Is the retina endangered when its foremost part is reached by the therapeutic punctures? According to my experiences up to now I can reply in the negative. Haemorrhages in the periphery of the retina are not to be feared, as only capillary vessels reach this part of the retina. One must however bear in mind the possibility of a haemorrhage of the choroid and I think that as in detachment operations such haemorrhages will sometimes occur. The safest way of avoiding this is the use of a needle of the above mentioned fineness and shortness. In the course of our observations haemorrhages were rare exceptions.

We must make some mention as to the possibility of a necrosis of the sclera. I had a case of a sixty-one year old emmetrope who had had repeated trephinings and had lost his right eye. The tension was 30-35 mm. Hg which had eventually resulted in reducing the visual field on the nasal side almost to the centre, although two trephinings had been made twelve years ago and pilocarpine-eserine had been given six times daily over a period of many years. I made a very extensive C.D.P. below. After 10 days a small necrosis of the sclera with a drop of vitreous in the centre was noticed in the region of the C.D.P. about 6 mm. from the limbus and with a diameter of about 3 mm. A conjunctival flap was carefully placed over the spot without touching the vitreous but it detached itself again after three days, so that I had to sew the sclera (going through sclera and conjunctiva with a fine needle made by Grieshaber after my special instructions and with fine black silk without touching the vitreous), and this definitely closed the opening of the sclera. The thread was left for 6 days and the tension to-day 3 months after the operation is normal to subnormal, no drops being used; retina normal; vision and visual field as before the operation.

Examples of the Method of Operation

Above all we employ the C.D.P. almost exclusively in cases of glaucoma haemorrhagicum, further in cases of aphakic eyes or after contusions where glaucoma is caused by the vitreous

obstructing the angle of the anterior chamber, as well as in the similar cases of traumatic or spontaneous luxation of the lens. In the remaining cases the C.D.P. is a secondary operation after iridectomy or an operation aiming at subconjunctival filtration, sclerotomy or cyclodialysis had been previously performed without success.

As a rule we perform the first C.D.P. below (Fig. 2). Subconjunctival anaesthesia with novadrin

(Novocaini hydrochl. 1·0
Adrenalin hydrochl. 1 : 1,000 gutt. X.
Aq. dest. ad 50·0.)

The lids are held apart with hooks. An incision of the conjunctiva near the insertion of the rectus inf. is then made which reaches on the nasal and temporal side to the insertions of the rectus int. and ext. The rectus inf. is completely anaesthetised with 1 c.cm. novadrin. The sclera and the insertions of the rectus inf. are then laid free of the conjunctiva. Within a zone of 1-2 mm. width along the limbus we do not detach the conjunctiva. The completely anaesthetised insertion of the rectus inf. is then narrowed through short incisions on both sides, but care is taken not to sever it. Now a girdle of about $2\frac{1}{2}$ mm. in width just above the insertion and between the insertion and the limbus is punctured with the diathermy-needle (length 0·5 mm.; thickness 0·16-0·18 mm.) using about 60 milliamperes (zone *a* Fig. 2) in such a manner that the needle (furnished with a stop) is pushed into the sclera vertically and at intervals of $\frac{1}{2}$-1/4 mm. and is left there for from $\frac{1}{2}$-1 seconds. We then work upon the parts marked *b* and *c* the punctures reaching as far as the insertion of the rectus inf.; on the nasal and temporal side the punctured areas reach to within a distance of 2 mm. of the insertion of the rectus med. and lat. *One must avoid approaching the limbus corneae with the punctures nearer than 2-2½ mm.*

The surface of the sclera must be carefully kept dry of blood and vitreous before inserting the needle as otherwise there is the risk of the needle being cold while being pushed into the sclera. Only the point of the needle which punctures the sclera becomes glowing hot.

After placing a hundred or more punctures the conjunctiva is carefully resown with catgut. Afterwards a sterile bandage with an ointment of boric acid.

Usually the eye is very hypotonic immediately after the operation.

If the tension is not very low on the second day pilocarpine can be given.

Frequently the tension becomes normal only several days after operating.

When operating above or on the nasal or temporal side the proceeding is the same.

Let us consider in what topographical relation to the ora serrata we find ourselves when we insert the needle in front of and behind the insertion of the straight eye-muscles. E. Fuchs gives (*Graefe's Arch. f. Ophthal.*, Vol. XXX., p. 1, 1881) the following distances of the muscle-insertions from the limbus: M. rectus medialis, 5·5 mm.; M. rectus laterialis, 6·9 mm.; M. rectus sup., 7·7 mm.; M. rectus inf., 6·5 mm.

The distance of the ora serrata from the limbus according to the above cited measurements of Hans Wagner is in the emmetropic eye 5-7 mm. on the nasal side (insertion of the muscle according to Fuchs 5·5 mm.). Nasally it coincides therefore approximately with the insertion of the muscle. On the temporal side, above and below, the distance of the ora according to Wagner measures 6-7½ mm. and accordingly the insertion coincides here, too, with the outer border of the retina within a fraction

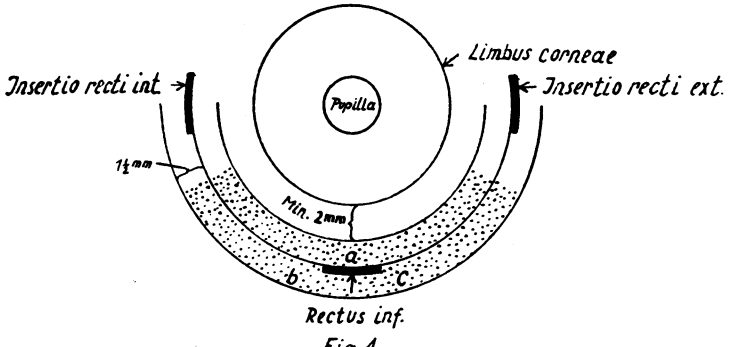

Fig. 1

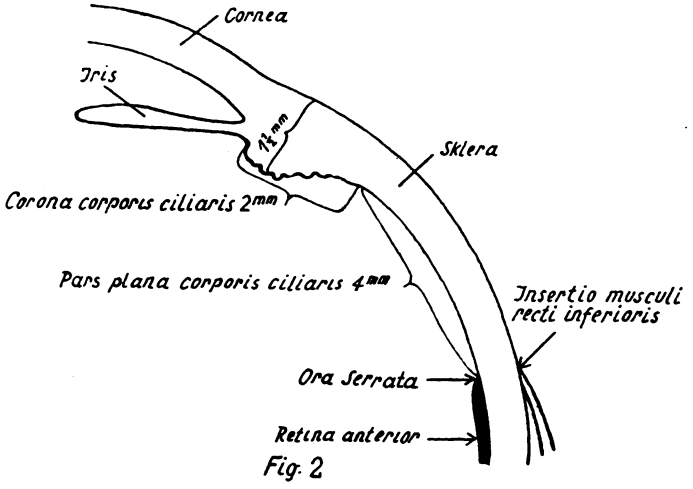

Fig. 2

of 1-1½ mm. at the utmost. We thus get close to the nasal serrated border of the retina if we make our punctures close to the insertion, but when 2-4 mm. in front of it, to the neighbourhood of the pars plana corporis ciliaris (Fig. 1) *i.e.*, to the rear part of the corona ciliaris.

My own experiments with some freshly enucleated eyes 23-25 mm. long confirm these findings. I halved the eyes in the equator after they had lain in formalin for several hours and inserted a needle close behind the insertion of the M. rectus int., sup., lat. and inf. I could see the point of the needle emerging exactly in the region of the ora serrata or close in front of it, in the pars plana. The needles which I used were 5 mm. long. Such experiments are also in other ways very instructive for topographical studies of the eye. If after halving the eye we insert the needle from the inside into the inner surface of the ciliary body vertically right through the sclera the point of the needle emerges on the outside 1-1½ mm. from the edge of the cornea. If we therefore wish to perform the C.D.P. on the most anterior and thickest part of the ciliary body we must insert the needle very close to the border of the cornea. If we want to reach the rear margin of the corona ciliaris we must insert our needle 2 mm. away from the margin of the cornea. On the other hand, in order to reach the posterior margin of the ciliary body, the ora serrata, *i.e.*, the front part of the retina, I would have to insert my needle at a distance of 6 mm. from the margin of the cornea, *i.e.*, approximately at the insertion of the muscles.

We can as yet scarcely give a theoretical explanation for the C.D.P. While developing the C.D.P. method I took for granted the correctness of the generally accepted theory, that the aqueous fluid is secreted by the ciliary body. A reduction of this secretion by damaging the ciliary body may possibly lead to a lowering of the tension in cases of glaucoma, eventually even to a state of balance. We know that certain diseases of the ciliary body show a low tension and many authors think that the hypotonic effect of cyclodialysis is caused by damage done to the ciliary body. Whether cauterisation of the ciliary body as a result of the C.D.P. tends to work in this direction I cannot say. Histological findings, regarding which I intend to report later on, appear, however, to confirm that the epithelial cells of the ciliary body and especially of the pars plana are affected. Such permanent damage would explain why some of my successful cases three years after being healed of primary glaucoma by C.D.P. withstand the application of mydriatics, homatropine and atropine without showing any pathological increase of tension. We must therefore conclude that certain forms of glaucoma must have quite

a different aetiology from the hitherto accepted theories propounded by Knie and Weber, *i.e.*, it is a matter of a too abundant secretion of aqueous fluid in comparison to its means of drainage rather than of a clogging of the anterior drainage. But other possibilities must also be considered. Let us be satisfied with the fact that the C.D.P. can be of use in the severest cases of glaucoma.

AMBLYOPIA EX ANOPSIA IN CHILDREN

BY

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A New Type of Ventilating Occluder

AMBLYOPIA ex anopsia in children is an ever growing practical problem. Among the school children of Essex there are approximately 2,500 " squinting " children, this total including only those children who come directly under the control of the Essex County Council Ophthalmic Service, and excludes those cases which are to be found within the autonomous borough councils. When one considers the problem from a national angle the total number of " squinting " children must reach staggering proportions. The incidence of " squint " appears to be increasing.

School children in this country are not all treated by ophthalmic surgeons and the result is that amblyopia must predominate in those areas where this specialised service is not available, although it would be very wrong to state that it was limited to these areas.

The fact is that most parents are not sufficiently well informed in a lay sense on the disabilities resulting from " squint," that many school medical officers are completely ignorant of the urgent necessity of getting the amblyopic eye to " see " as soon as possible, and that those who do attempt to counteract the amblyopia become discouraged when the instruments, which they are asked to use, break down in practice. The average medical officer finds it hard to decide when amblyopia is present in younger children. Moreover, the practice of *not* doing a post-retinoscopic subjective test is still very prevalent.

Also a satisfactory occluder for these cases has not been designed, although much time and patience have been put into this problem, as is evidenced by the numerous types of occluder to be found on the market, each in its turn attempting to counteract the disadvantages of previous models.

To aggravate the problem a great number of these " squinting " children are not detected until they reach the infants' department