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By G. A. BERRY, M.B., F.R.C.S.Ed.

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GLAUCOMA IRIDECTOMIES.

By G. A. BERRY, M.B., F.R.C.S.Ed., *Consulting Ophthalmic Surgeon, Royal Infirmary, Edinburgh.*

IT is now fifty years since v. Graefe published the first of his classical papers on the treatment of glaucoma by iridectomy. At that time, although he had only begun this treatment the year before, *i.e.* in 1856, he had already, with a clientèle which was even then truly enormous, acquired a not inconsiderable experience of its more immediate effects.

Much that is now known as regards glaucoma was unknown to v. Graefe. He believed the iris to be a secreting membrane, and the rise in the tension within the eye, which characterises the glaucomatous condition, to be due to increased secretion from its surface. The iris, it is now known, is not a secreting membrane—at least not in the ordinary sense. When inflamed, its vessels exude, no doubt, as do blood vessels elsewhere under similar conditions. To some extent, on the contrary, the iris is an absorbing surface. But the extent to which, under normal, and still more under abnormal conditions, its vessels and tissues absorb is as yet not clearly established.

v. Graefe was ignorant of the effect of miotics in glaucoma. Although he recognised, and was the first to recognise or to prove conclusively, that increased intra-ocular tension was the essential characteristic of glaucoma, he was not aware that the rise in tension was due to a disturbed balance between the transudation into, and the elimination from, the eye of the bulk of its nutrient liquid. Still less did he know that what upsets the balance is generally, if not always, defective elimination, not increased transudation.

Physiological experiment and pathological examination have demonstrated more and more clearly the preponderating rôle played by the tissues at the angle of the anterior chamber in providing for excretion. Indeed, as will be referred to later on, this knowledge has had important bearings—not always, I believe, altogether happy bearings—on the treatment of many cases of glaucoma.

v. Graefe began his operation on what must be looked upon as a purely empirical basis. He had observed that iridectomy, performed in cases of partial corneal staphyloma, tended to prevent further ectasy of the imperfect cicatrix, and thus admit of its more complete consolidation and consequent greater power of withstanding the pressure of the liquid contents of the anterior chamber. He argued that the effect of the operation done for this purpose was to reduce tension—as no doubt it does temporarily

to much below the normal amount, owing to the escape of aqueous—and inferred that the tension in glaucoma might be reduced in the same way.

The cases are, however, by no means parallel. In point of fact, they are barely, if at all, related. Yet the effect of iridectomy at once proved in his hands to not only temporarily but permanently reduce the abnormal tension, and thus arrest the process of destruction caused by the disease.

No more beneficent operative procedure than iridectomy for glaucoma exists probably in the whole range of surgical operations. Yet the operation is still an empirical one. It remains to be shown why iridectomy should be capable of permanently reducing increased tension within the eye. The most curious point, however, in connection with this treatment—the brilliant results of which its author lived long enough to prove to be lasting and to see generally recognised—is that its value is even to-day very differently appreciated by different operators. In other branches of surgery an operation which has been introduced and adopted for any definite condition is either abandoned altogether for some better treatment, or modified in different ways at the hands of different surgeons. It is either superseded altogether or perfected.

It would not appear at first sight, however, that so simple a proceeding as cutting into the eye and removing a piece of the iris would admit of much variation. Yet although every writer who gives his experience of iridectomy for glaucoma simply discusses the question of how far his statistics show this to be the best treatment or not, as compared with other methods of treatment which have since been recommended, every one does not by any means operate in exactly the same manner.

Of the literature which has appeared on the subject of glaucoma since v. Graefe's time—which in bulk would no doubt fill a small library—there continue to be published every year not a few papers, more or less exhaustive, dealing with the practical question of the results of operation. In almost all the large foreign clinics at least, statistics are from time to time given. These vary so much that they are often more bewildering than useful. Some surgeons actually discard iridectomy altogether, others only iridectomise in cases of more or less acute congestive glaucoma, whilst some continue to regard v. Graefe's operation as indispensable in all cases. Provided the statistics are carefully and conscientiously drawn up—which many at least bear evidence of being—and provided that the technical skill of the operators does not vary so widely as to make any material difference,—which I think must be admitted in the case of surgeons of experience,—it follows that there must either be some confusion in the classification adopted by the various writers, or some difference in the method of operation, or both. I believe there is both.

I propose here to discuss the matter as it presents itself to me from a large operative experience. Hackneyed as it no doubt is, the question of the treatment of glaucoma is far from being sufficiently settled. It is one, therefore, on which any one who is entitled to hold definite views, arrived at by long clinical experience and not only by theory as to pathology, is also justified in setting them forth. I have done so before, shortly, in a paper read before the Ophthalmic Section of the British Medical Association and also in my "Manual of Practical Ophthalmology." What may be looked upon as the jubilee of iridectomy for glaucoma seems, however, a fitting occasion to do so again.

As regards statistics in the first place. They are based upon classifications which of necessity are not always easy to follow. The same group for one classifier may not contain exactly the same class of cases for another. The reason for this is that *glaucoma*, although the name attached to a class of disease which is always essentially the same, no doubt, so far as etiology goes, not only embraces the most varied types of cases, but no type can be said to be even approximately distinct. There is, in fact, a gradual transition in character in this disease from the most violently acute, fulminating, congestive glaucoma, which may irremediably abolish the sight in a few hours—or even, as I have seen in one case, in a few minutes—and the slow, non-congestive process known as glaucoma simplex, in which the destruction of vision may take twenty years or more in being accomplished.

Where, then, are the lines to be drawn? Obviously they are not likely to be drawn similarly by every statistician. Even the same observer must have a difficulty in classifying every case exactly in accordance with the groups he has imagined. With the best of intentions he might allocate very similar cases to different groups, so as to fit in with his preconceived notions as to how they are likely to be affected by the treatment which he either believes or disbelieves in. For instance, it is customary to distinguish between congestive and non-congestive glaucoma, or rather it is this distinction which is meant when the respective cases, as they still often, though wrongly, are referred to as "inflammatory" and "non-inflammatory" glaucoma. But as many cases are at one time congestive and at another not, and of these, some more often of the one type than of the other, it is practically a "toss up" in which connection they will be placed in a statistical statement. If one could even be sure that cases which are mainly congestive though occasionally non-congestive were always given a place in the congestive column, and those mainly non-congestive but occasionally congestive, in the non-congestive column, some guide would be afforded to recognise what was referred to.

Then there is the still more difficult distinction attempted often between a chronic non-congestive glaucoma and what

Donders and v. Graefe called glaucoma simplex. Indeed, it is far from certain that there are not included in many glaucoma statistics cases which are essentially not cases of pure idiopathic glaucoma at all. v. Graefe first classified the type which now goes by the name of glaucoma simplex as amaurosis with excavation of the optic nerve. In this group he recognised a similarity to glaucoma, but only after some time accepted the name proposed for the type by Donders. The original "glaucoma simplex" is, however, certainly not the invariable type to which different writers give that name.

Then there can be no doubt that surgeons in different parts of the world, and in different parts of the same country, see the cases which they are called upon to treat at different stages of the disease. This is particularly the case where only one eye is affected, and there is a difference in this respect too between private and hospital cases. The general practitioner is often blamed for overlooking a glaucoma, and thus losing valuable time, to the injury of the patient, who in consequence may lose his sight altogether, and certainly always necessarily loses more than might have been the case had he been properly treated at an earlier stage. All oculists have had many experiences of this. But the great variation in the degree and even in the character of the symptoms of glaucoma cases makes it almost inevitable. I have rather been struck by the frequency with which the general practitioner, in Scotland at any rate, who must keep abreast of so many other matters, recognises, or at least suspects, glaucoma,—all the more, too, when one considers that the diagnosis is by no means always as easy a matter as might be supposed, even for the expert. Cases of the more or less non-congestive type do not so altogether infrequently escape the notice of the ophthalmic surgeon.

As to diagnosis, it is only such cases and cases of real glaucoma simplex that should present any difficulty. In an exhaustive treatise, published some years ago by one of the most experienced oculists of Paris, v. Wecker, a great deal of space was devoted to the subject of the diagnosis of glaucoma simplex. In that treatise many cases are recorded in illustration of the author's remarks on diagnosis. Yet these cases are certainly not all recognisable as glaucoma simplex. Not a few of them are not recognisable as glaucoma at all. The upshot of v. Wecker's remarks, so far as a very confused treatment of the subject admits of their being understood, appears to be that it is not always possible for any one else but v. Wecker to diagnose glaucoma simplex! Where, then, is the general practitioner as regards glaucoma simplex, if only one man exists who can invariably diagnose it?

Fortunately things are hardly as bad as v. Wecker would have one suppose. He had, too, arrived at this enviable proficiency

in diagnosis without having learnt the value of a symptom which was nevertheless known to many at the time he wrote. That symptom is probably, if not certainly, absolutely characteristic of glaucoma, and is invariably found in glaucoma simplex even before the disease has advanced sufficiently to make any other-wise appreciable diminution in the functional activity of the affected eye. It is what is known as Bjerrum's symptom, and consists of a characteristically shaped relative scotomatous area which can readily be detected by a suitable method of subjective examination. Thus, if the field of vision be explored with a white object against a very black background, an object so small that it subtends an angle to the eye of about 5'—which in practice is got with a small disc 3 mm. in diameter, held against a black velvet screen at 2 metres distance—then an extremely small amount of pressure paresis of the optic nerve is revealed. There is by this means demonstrated, without difficulty, a defective area, extending always from the blind spot in some direction. Though distinctly visible in other parts of the field up to its limits—which are greatly restricted in all directions for such a small object as compared with the area over which some visual power exists—this object is lost to view not only at the blind spot, but over a very much larger area, which is, however, always in direct continuity with the blind spot. The value of Bjerrum's symptom is of course, from a diagnostic point of view, most evident in cases in which good central vision still exists; as that is the kind of case in which a doubt as to the presence of glaucoma may be entertained. From the point of view of pathology, it is of course also suggestive of the blindness caused by glaucoma being due to the effect of pressure on the optic nerve itself. The retinal vessels, it has been supposed, suffered from the pressure, and thus the nutrition of the retina became impaired, and its functional activity lost. Bjerrum's symptom points to the nerve, but in addition to this the intra-ocular pressure probably never rises as high as the arterial pressure in the retinal vessels, even when the eye is stony hard; and most cases suffer a progressive blindness, with much less—sometimes, indeed, with a hardly demonstrable—increase of tension.

So far as my experience of Bjerrum's test goes, which extends back to the time 1889, when it was first introduced, the peculiarly situated relative scotoma thus shown is quite characteristic of glaucoma, and does not occur in optic atrophy. This has been very fully confirmed recently by Dr. Arthur Sinclair, who carefully examined a number of cases of glaucoma, and compared them as regards this symptom with other affections in which the optic nerve is involved. So delicate is this test, that in not a few cases in which there has been no other indication which would have led one to suspect glaucoma at all, except the

existence of a more or less marked glaucoma in the other eye, where in fact there has been full vision as tested with the ordinary test types, the characteristic relative scotoma has been detected. This was first done in cases of my own by Dr. Ramage, my house-surgeon, at the time in 1890, and recorded by him in his thesis for M.D. Practically, then, it may be said that the diagnosis of any case of glaucoma is always possible.

One is accustomed to recognise in many cases of glaucoma what is called the premonitory or prodromatous stage, *i.e.* the stage in which such indications as corneal haze with its attendant cloudy and rainbow vision, more or less pain, etc., occur occasionally, but disappear without leaving any trace so far as an ordinary subjective examination suffices to detect. Whereas so soon as demonstrable defects remain permanently after the tension has subsided, the disease is looked upon as being "confirmed." With the screen test, however, pressure symptoms are found indicating that a glaucoma is really confirmed before it would otherwise be looked upon as having passed the prodromatous stage. This is important as regards treatment, as will be seen later on.

From the point of view of statistics, there is, then, both the question of discriminating with certainty between glaucoma simplex and optic atrophy—which is not always done—and the question of drawing a hard-and-fast line between such cases and the only slightly congestive type into which they insensibly merge—which is impossible.

A fairly useful classification for statistical purposes, though still not free from the sources of confusion to which I have referred, would be into (α) acute congestive glaucoma, (β) chronic markedly congestive glaucoma, and (γ) chronic non-congestive glaucoma, including in the last category cases which only occasionally exhibit slight signs of congestion, but which are mainly characterised by more or less increased intra-ocular tension at times, excavation of the disc of a glaucomatous type, spontaneous or readily elicited arterial pulsation, failure of central and peripheral vision however slight, without at any time, or only very rarely, presenting any congestion, corneal haze, corneal anæsthesia, or spontaneous pain.

As has been said, v. Graefe was not aware of the importance of inducing miosis in glaucoma. This was subsequently discovered by Laqueur. Pilocarpine and eserine, on account of their miotic action, now form an indispensable part of one's treatment of glaucoma, and that whether operative treatment has been resorted to or not. The rôle played by the tissues at the angle of the anterior chamber has also been referred to as having had an influence on the question of treatment. The filtration channels in this situation may become temporarily or permanently blocked, and as they undoubtedly are the main excretory channels, this

blocking, by causing excretion to fall behind transudation from the ciliary processes, leads to a disturbance of balance and consequent rise of intra-ocular pressure. Theoretically, the pressure within the eye might rise to equal the blood pressure in the arteries of the ciliary processes, which is, roughly speaking, twice as great as that distending the eye. This, however, never appears to happen, unless perhaps in fulminating glaucoma. The increased tension usually falls far short of the blood pressure. Even a slight pressure within the eye will cause damage which, if continued for any time, is permanent. In this respect it is probable that individual differences exist. At all events it is astonishing to find in some cases of simple glaucoma how little evidence of tension may exist along with sufficiently well-marked pressure symptoms.

Taking the two points together, the effect of a miotic in reducing abnormal tension and the effect of blocking of the angle of the anterior chamber in causing the tension to rise, it was natural enough to conclude that the effect of a miotic was due to the iris periphery being thereby dragged upon so as to free the angle. A similar effect of iridectomy was also inferred. This led many to believe that the section into the eye, and not the removal of a piece of iris, was what gave the desired result. This diverted attention from the iris to the incision, and caused speculation and experiment as to the exact position which should be given to it, with the result that there originated a rival operation to iridectomy for the cure of glaucoma. Many gave up the excision of a piece of iris, and confined themselves to making a large and very peripheral section into the eye. This operation, however differently it may be done, is what goes by the name of sclerotomy.

This proceeding, adopted then in the first place in the light of a clearer conception of the physiology of excretion from the eye, seemed also to be indicated by the rules which v. Graefe had laid down, as the result of his large experience and keen insight, for the successful performance of iridectomy in glaucoma, particularly by the point on which he laid stress, namely, the importance of making the incision at the corneo-scleral margin as peripheral as possible. Some have apparently been content to adhere to sclerotomy and to substitute it for iridectomy in all cases of glaucoma. The majority of operators have found, however, that not only can iridectomy not be altogether discarded, but that, in the congestive type of glaucoma at least, it is more effectual than sclerotomy.

In my opinion, those who have been greatly influenced by the current theories as to the pathology of glaucoma, and have in consequence attached primary importance to the incision, even when they have not given up the excision of a piece of iris, have come to perform the operation of iridectomy in glaucoma in a

way which not only does not give the best results, but sometimes even defeats its own object. To understand this fully, however, it will be well to consider what were the rules which v. Graefe instituted, and how they were arrived at—rules which in the majority of instances are still adhered to or are at least believed to be followed.

v. Graefe from the first recognised that the object of an operation for glaucoma must be to provide for the reduction of tension, and he kept this aim consistently in view. Shortly, the three classical rules are—(1) The incision must be made as peripheral as possible; (2) the portion of iris removed must be as large as possible; (3) the aqueous humour must be allowed to escape slowly.

His exact words with regard to the first rule are—"The wounds must be placed as excentrically as possible, so that the outer wound comes to lie $\frac{1}{2}$ " into the sclera, while the inner wound falls exactly in the boundary between cornea and sclera. In this way it is possible to remove the iris right up to its ciliary insertion, and it appears that this is necessary to get the result, or at all events insures its being got."

Two remarks on these sentences suggest themselves—(1) Although v. Graefe recommends that the incision be made as peripherally as possible, the further description of its site does not altogether bear this out; as described, it is *not* what one would call an excessively peripheral incision; and (2) evidently he attached importance to the removal of the periphery of the iris. To these points I shall, however, return later on.

With regard to the second rule, v. Graefe says: "The excised piece (*of iris*) must be as large as possible"; and further on, "The more intense the process, the more pronounced the increased tension, the more extensive do I advise the excision to be made."

On this, too, the following remarks are suggested: (1) We now know that it is impossible, short of actually tearing it away, to remove the iris right up to its peripheral attachment; and (2) v. Graefe was influenced as regards the amount of iris which he thought right to remove by his idea already referred to, that it was a secreting surface, and that increased secreting from it constituted an element in the disease. Moreover, finding this treatment successful, there would be no motive to change it. I can at least find no evidence that he ever tried smaller excisions.

The third rule calls for little comment. Every operator knows from his own experience that the aqueous humour must be allowed to escape slowly. Serious consequences may result from inattention to this point in cases where the tension is very high at the time of operation. Accustomed as one is to the importance of this rule, nothing looks more rash and inexperienced than to see an operator quickly withdraw his knife in operating for glaucoma, as if he were afraid of it!

v. Graefe made his incision with the lance-shaped bent keratome. He regarded the use of the narrow cataract knife for this purpose as an unimportant modification, but did not altogether condemn it. Although from his own description his incision would not appear to have been extremely peripheral, I have heard from those who saw many of both his earlier and later operations, that he regularly did make it, or aimed at making it, as peripheral as was possible with any safety. This practice often caused very disturbing hæmorrhage and other difficulties, so that a good many of his pupils were led to make the opening into the anterior chamber less peripheral than he did himself.

I have no doubt, from an experience with both instruments, that it is safer and easier to make a really clean peripheral wound with the lance-shaped keratome than with the Graefe knife. For many years I have invariably used the former, and only resorted to the narrow knife in exceptional cases, where the eye has been deeply sunk in the orbit and the palpebral opening small. The lance-shaped knife undoubtedly causes less disturbance of the parts, and enables one to make a section into a shallow chamber much more satisfactorily. The attempt with the Graefe knife to make a good peripheral incision often leads to dragging of the iris periphery in front of it, and other difficulties which ought to be avoided. Indeed, when compelled to use the narrow knife, I do not attempt as peripheral a section as if I were making use of the lance. The fear that with it the lens may be wounded I have not found justified. After a long experience of it, I do not remember of this accident occurring except on one occasion, which happened also to be one of the very first cases I operated on, where the accident was entirely my own fault. The knife has to be pushed rapidly into the chamber, and its point directed forwards the moment the resistance of the coat of the eye is felt to cease. Sometimes in particularly difficult cases the iris may be punctured towards its periphery by the point of the knife, but this need not deter one from finishing the section.

In v. Graefe's later papers, allusion is made several times to the question as to how far operation, in strict accordance with the rules he laid down, was necessary in order to secure the maximum of success. One passage bearing on this point may be quoted; he says of the effect of iridectomy in congestive glaucoma: "Although it is certainly advisable in this case also to make the excision of the iris large and as peripheral as possible, yet the non-fulfilment of this condition does not always or even generally lead to failure in the result of an iridectomy. I have seen a very large number of eyes affected by marked inflammatory glaucoma in which the iridectomy done has badly complied with the prescribed conditions, but in which nevertheless a permanent cure has been attained. The more the disease comes on with a sudden turbidity of the media, the more does

the real crux of the operation appear to lie in the excision of the sphincter pupillæ, whilst the really strict glaucoma operation becomes the more indispensable the freer the particular type is from turbidity of the media, and is characterised only by increased tension. I do not wish by these remarks to encourage the mistake of making a careless excision of the iris in primary inflammatory glaucoma. On the contrary, I consider that even in such cases the eyes are more fully secured by operation done according to the recognised rules."

Another fact which seems to have weighed with v. Graefe in recommending a very large iridectomy, was that in cases in which a first iridectomy had failed to give a permanent result a cure was sometimes effected by doing a second iridectomy.

I have not been able to find whether v. Graefe ever experimented in the way of making any modification in his method of operating in the case of non-congestive glaucoma. Evidently, however, he or his pupils must occasionally, and no doubt unintentionally, have failed to adhere to the rules which he had formulated. In his paper of 1862 there is a passage which shows this. After referring to cases of acute glaucoma operated in the early stage in a way which fell short of that prescribed, he adds: "As, however, in other cases, particularly cases of chronic glaucoma, the effect under such conditions turned out to be insufficient, and a second iridectomy was required, the rules as they stand are thereby confirmed, and great weight has to be attached to them in chronic glaucoma and the later stages of acute glaucoma."

It may be remarked that in non-congestive glaucoma it is almost always a comparatively easy matter to operate with precision. The effect of operation is, however, in many of these cases less certain. Consequently it is not unreasonable to suppose that v. Graefe's main reason for continuing to advocate a close adherence to the rules which he had established, was that being satisfied with them he saw no object in modifying them.

The point referred to in the quotation at p. 387, in which there is attached a primary importance to the excision of the sphincter pupillæ, is interesting, as some subsequent operators have held quite an opposite view, and have recommended and practised the retention of the sphincter. Snellen, for instance, whose practical experience was great, and whose judgment was of the highest order, believed in leaving the sphincter, while making a free excision of the more peripheral portion of the iris. Here however, the effect of a miotic influenced the new view as to the most suitable way of operating. By the retention of the sphincter it was thought, and perhaps rightly, that the subsequent effect of treatment with a miotic must be more effectual. Still it is open to doubt whether as an operation this way of performing iridectomy is really as effectual as that more generally in use, in which the sphincter is included in the portion of the iris excised.

With regard to miotics, their constant use in practice in the present day has introduced a question of importance which necessarily presented itself differently to v. Graefe as well as to his contemporaries and immediate successors, many of whom were also his pupils and greatly influenced by his teaching. That question is: What is the course of a glaucoma according as iridectomy is done for it or not? The previously known medical treatment—and many things had been tried—had certainly very little influence on the course of glaucoma. By the use of miotics, however, it is by no means easy to assert positively whether certain cases would do, or actually do, as well or better than when subjected to iridectomy.

Comparatively little is known as to the average course of a non-congestive glaucoma which is left to itself or treated with miotics alone. Statistics on this point are not, so far as I know, available. They would probably be of little use unless, perhaps, they were drawn up by a single observer of judgment and large experience—which would at all events ensure that the cases compared were fairly similar. It is evident that this even would not remove difficulties which would detract from their value.

My own experience, without attempting anything of the nature of statistics, would lead me to favour iridectomy in all cases. I can at least recall a good many cases in which a patient was refused, or has not returned for, operation in the second eye, and in which the disease in the iridectomised one has either been permanently checked or has progressed less rapidly than in the other. In some of these cases the second eye had been treated continuously with miotics, and yet had failed more rapidly than the one which had been iridectomised. Having always made it a rule to operate on the worse eye first, except where it had lost all useful sight, there could be no doubt of this, even in cases where it was difficult, as sometimes happens in hospital practice, to consult the records after a long interval of time.

Another point that appears to me to be more than suggestive in support of the superiority of iridectomy over treatment with miotics is, that I could point to not a few cases which I have had under observation from time to time for twenty years and more, in which after an iridectomy done at so late a stage of a chronic glaucoma that only a portion of the outer field remained, no appreciable change has afterwards taken place. The small amount of sight existing at the time of, or immediately after, the iridectomy has stood for all these years. A similar result has never once come under my notice in cases under miotic treatment alone. I have seen many remnants of vision go entirely. I have never seen any retained for many years. The fact that I have made a habit of continuing miotic treatment even after iridectomy, does not alter the conclusions which one must naturally draw from such an experience. It is, of course, possible that iridectomy

plus the continued use of miotics may be better than iridectomy alone. Indeed, it is the extra chance that miotic treatment seem to offer in consolidating the effect of iridectomy that leads one to adopt it. It may do no good. It is pretty certain, on the other hand, that it does no harm.

My experience of glaucoma iridectomies is that when the operation succeeds in causing a permanent reduction of tension the disease is stopped and no further destruction takes place whatever may have been the stage arrived at or the type of the disease for which iridectomy has been done. v. Graefe believe that a stage might be reached at which degeneration would proceed independent of any return of glaucomatous symptoms. This is certainly not the case, nor do I suppose there are many at the present day who believe it to be so. On the other hand the stage as well as the type of the disease has an undoubted bearing on the efficacy of the operation to permanently reduce the tension.

It may be taken as a quite general experience, that the more chronic, less congestive and older standing, is the condition of glaucoma for which an iridectomy is done, the more doubtful will be its effect. All things considered, it is natural enough that the matter of the line of incision should have so long engaged the attention of operators. In my opinion, however, too little importance has been attached to the possible disadvantage entailed by what may be looked upon as an excessively peripheral section.

Many have been led, by consideration of the points to which I have referred, to conclude that the incision should, as far as possible, actually lie in, or aim at opening out, the space of Fontana at the angle of the anterior chamber. Everyone who has been tempted to try to get an incision so far back as this has experienced an increased difficulty in operating owing to the hæmorrhage caused by the general hacking up of the tissues, the subsequent enclisis and irregular healing which is caused more particularly when the narrow Graefe knife is used. Nor is there, so far as I can judge, any sufficient evidence to show that such very peripheral incisions are better than less, though still excentric incisions which suffice for the removal of iris quite as near to its root. I cannot see how a wound made in the tissues which normally provide for filtration, but have become more or less blocked, can be calculated to permanently improve the patency of the filtration channels. Cicatrisation in such a wound, particularly if, as so often happens, it is not a clean cut into the coats of the eye alone is surely more likely to seal up the existing channels more effectually than ever.

That this is not so often the case, or that the effect of doing so should not be so apparent, as might be expected, is, I believe due to two circumstances. In the first place, the attempt to

make a section actually lie in the space intended may not be successful, and cicatrization near to but not in the filtration angle may conceivably have the effect of freeing it to some extent. In the second place, such very peripheral sections are often followed by an imperfect scar, a cystoid scar, one which therefore admits of more or less filtration, and in fact comes to act as a kind of safety valve.

There is no doubt that a filtration scar of this kind may be of use as a means of arresting glaucoma in some cases. Everyone who has had much experience of glaucoma operations will know of cases where the cystoid cicatrix is more or less evidently what stands between the eye and its complete, or at least its more rapid, destruction. Of not a few cases of this kind which I have seen, I may mention one which I have had under observation for eighteen years now, in which the scar has remained cystoid, and has its efficiency as a filter increased from time to time by the habit which the patient has acquired, of forcibly rubbing his eye when he notices it become obscured. This causes a trickle of aqueous humour to escape, of which the patient is conscious, and which is immediately followed by the disappearance of haze.

But though ready to admit the value, under certain conditions, of a cystoid cicatrix, I am far from believing that it should be courted as it were, as some think, and that the incision should be purposely always made so as to lead to a filtration scar. Apart from the danger that there is of such a scar becoming infected, and thus lead to serious inflammation or even purulent destruction of the eye, the condition is one by no means ideal as a cure for glaucoma. In some desperate cases, and particularly in advanced buphthalmos—the form which glaucoma assumes in children—I do aim at getting something of the kind, that is, I make a double puncture (puncture and counter-puncture with a narrow knife) of the eye, so far back as to pass through the iris to considerably behind its root. In buphthalmos, however, except at an early stage, it is not safe either to make a large incision or to remove a piece of iris.

As regards sclerotomy in glaucoma, I have not found it superior to iridectomy as a primary measure in any class of case. No doubt as a second operation when iridectomy has failed, it may be, in fact it ought to be, tried. But to this I shall return. My experience leads me to think that the only chance of success when sclerotomy is done as a subsequent measure, is in the production of a filtration scar. My own practice is to recommend *iridectomy in all cases, whatever the stage or type of the disease, so soon as there is any demonstrable evidence of its being confirmed.* This includes, as already explained in referring to Bjerrum's symptom, many cases which are still apparently only in the prodromatous stage.

I do not go so far as to propose operation whenever there

have been prodromata, but only do so if some real and permanent loss of functional activity of the eye has been sustained. There are cases in which prodromata occur at very rare intervals, and can be quickly checked when they do occur by the use of miotics. There are other much rarer cases, in which, notwithstanding repeated prodromata the vision remains unimpaired for years. The most striking instance of this kind that has come under my notice was that of a lady whose attacks of obscuration and rainbow vision came on for years practically almost daily, and passed off at once under pilocarpine without leaving any trace. Such cases one would naturally not operate upon.

Unfortunately the rule to iridectomise at the earliest possible moment in a confirmed case cannot always, or even generally, be put in practice. A large proportion of cases are first recognised relatively late in the progress of the disease, while in other cases it is not possible to obtain the sanction of the patient, who is unable to understand or realise the danger of delay. In these respects the surgeon is more favourably situated when the second eye is attacked. It therefore often happens that the treatment of the second eye, having been undertaken at an earlier stage, meets with more success than that of the first eye.

Early operation, then, is the first practical rule which I would emphasise. I do not believe in putting off time with miotics when the disease has really been confirmed. Miotics may, on the other hand, be used with advantage more or less continuously after operation. For this purpose, too, I prefer pilocarpine to eserine. My second rule is: *begin with iridectomy in all cases*. It is not only the most likely to prove effectual; it is also, with rare exceptions, the treatment which is least likely to do harm. Indeed, iridectomy when properly done is so safe, that it should never be put off on the plea that the patient still has very good sight in the affected eye. No doubt there may often be a slight deterioration following iridectomy, but this should be faced in view of the great chance which it affords of arresting the progress of the disease. The most serious cases to deal with in this respect are those in which very fair central vision coexists with a loss of the field close up to the point of fixation. Here an iridectomy may be followed at once by great deterioration of sight owing to the point of fixation being invaded. This risk is not so great in my experience as some seem to believe. It should not, I think, influence one in recommending iridectomy, though it is only right that the patient should be made fully aware of the existence of such a risk in his case before he consents to operation.

One of the rare exceptions to the rules to operate early and to begin with iridectomy is the case of true hæmorrhagic glaucoma—really I think a secondary rather than a primary glaucoma. My practice in such cases is to refrain from operating altogether.

Some remarks on the method of performing iridectomy must qualify the advice I have ventured to give above. In the first place, as already said, the instrument best suited for the purpose is the bent lance-shaped keratome, usually in this country referred to simply as the keratome. The degree of excentricity or periphericity of the section made with this instrument should, I think, vary according to the case for which the iridectomy is done. The guide should be the degree of difficulty which making a peripheral section presents. It is a mistake to attempt what is practically impossible, and important to remember that the section should not be made so very peripheral as to involve one in the difficulties which have already been alluded to. Fortunately, the cases in which it is very generally most difficult to get a very peripheral section, cases of acute congestive glaucoma, are also those in which it is least indispensable. In most cases of chronic only occasionally congestive, or of simple, glaucoma, there is no difficulty with the keratome in getting a section quite as peripheral as v. Graefe recommended.

A peripheral section has been sufficiently proved by general experience to be desirable. This being the case, it is perhaps of little consequence to consider why it should be so. Certainly the belief that it opens out the filtration angle is open to doubt, and has, I believe, led to much of the non-success which has occurred at the hands of those operators whose glaucoma iridectomies have proved unsatisfactory. A more probable explanation of why a reasonably though not excessively peripheral section should be useful is that it admits, while not interfering with the tissues too near the angle of the anterior chamber, of removing a sufficiently peripheral portion of iris.

Another point in the operation to which I would refer is the amount of iris which should be removed. Provided one gets a good depth of iris, I believe it is of little consequence how much is removed in breadth, or, in other words, what the size of the sector removed is. It must, however, be of some size not merely such as might be got by slitting it down radially. There must be a coloboma formed to prevent the possibility of union of the cut edges. But the width of the coloboma is in my experience apparently immaterial. At all events I have got as good results by making a coloboma of not more than 4 to 5 mm. in breadth, but carried well up to the iris root, as with the very large ones which used to be practised.

An important indication may be got very soon after operation as to whether the iridectomy is likely to prove permanently useful or not. The smoother and more natural the healing, and the flatter and more consolidated the scar, in the coats of the eye, the more likely is the operation to eventually prove successful. An ectatic, weak scar or a cystoid scar only comes, provided the operation has been done on the lines sketched above, when the

iridectomy has failed to re-establish a proper balance between transudation and excretion. Their appearance does not, however necessarily mean failure. Two things may happen. The scar which to begin with is weak and pouting, may, as more favourable conditions become slowly established, consolidate and flatten. Or, again, the scar may become a safety valve and filter some or all of the liquid out of the eye which should escape by the normal channels.

The object of this paper has been mainly to give my own views on the practical points connected with iridectomy for glaucoma, and this with reference to the cases and stage of the disease for which that operation is specially indicated, as well as to give certain details of the way of operating which are the outcome of what I have practically found to be important in order to secure the maximum of success. If, in conclusion, I venture to offer some suggestions in explanation of the action of iridectomy, I do so with much less confidence. My views on this subject have gradually formed from practical experience, along with a careful study of what is so far known of the pathology of the disease. The effect of the operation depends, I believe, mainly upon three conditions—(1) The state of the iris at the time of the operation; (2) the condition at the same time of the filtration angle; and (3) the manner of operating.

As time goes on in the process of glaucoma, the iris appears to undergo a change in the direction of atrophy. The more atrophic the iris the less is to be expected from the making of a coloboma in it. All parts of the iris do not, however, always seem to be equally degenerated, and hence it may happen that when one iridectomy has failed a second may prove successful. In this connection it is interesting to note, too, that v. Graefe was led by experience to advocate that a second iridectomy should be made opposite to the first. At one time I thought, influenced no doubt mainly by cosmetic considerations, that a second iridectomy might, with equal chances of proving successful, be made close up to the first, the original coloboma being thereby simply enlarged. I no longer hold that view. I believe v. Graefe was right in this, as he has proved to have been in so many other points. It seems indeed not unreasonable to suppose that a coloboma placed diametrically opposite to the first may have often a better chance of falling within an area of iris which is less abnormal, in which the vessels particularly have undergone less degeneration. When the iris has been cut its absorptive power is most likely increased. From being of comparatively little importance in excretion, it comes to take a larger share. This has not, it is true, been demonstrated conclusively, but is indicated by what actually takes place in so many cases. I have previously on several occasions, as, *e.g.*, in a paper in the *British Medical Journal*, referred to this as one probable element of the

action of iridectomy. Quite recently it has been shown by Henderson that after iridectomy there is never any cicatrisation of the stump of iris left, so that years afterwards it presents the appearance of having been cut post-mortem. This is important, as indicating that the explanation I have given would suffice to account for not only a temporary but also a permanently increased absorptive action.

Again, the changes which undoubtedly do take place in the meshes of the pectinate ligament at the filtration angle, and which as undoubtedly impair the function of this region as an excretory channel, cannot be removed by operation. On the other hand, I see no reason for supposing that they are progressive apart from the continuance of increased tension on which they seem to depend, as well as which they cause. This I argue from the fact already referred to, that cases operated on at a late stage may remain permanently cured. It is, of course, possible that sclerosis does proceed in that situation, and that the cut iris suffices for absorption. It is perhaps also possible that degenerative changes in the vessels of the ciliary processes which occur as the last stage of an absolute glaucoma may have begun, so that the balance between transudation and elimination may be in part maintained by transudation becoming less. Many reasons, to which I need not here refer, as for instance the behaviour in the case of cystoid cicatrix, make me incline to the belief that after a successful iridectomy the progress of sclerosis at the filtration angle ceases, and that the channels remain sufficiently patent to provide, along with the greater absorption from the mutilated iris, for an efficient balance.

How the manner of operating may act I have already indicated. In the first place, some importance must be attached to the mere respite which the wound opening into the eye gives before it heals firmly. The tension is thereby in almost all cases immediately reduced, and time is given for the eye to accommodate itself to the new conditions. As to the section, while it may, if placed too peripherally, possibly impede instead of improving the filtration, it cannot, I think, have any marked favourable effect of itself. Only when a re-establishment of equilibrium is not got by iridectomy does the question of what may be done by a section alone, come to be considered. An attempt must then be made to get a filtration scar. This I am of opinion is preferably done by means of a double puncture, placed so far back as to button-hole the iris, but only to make a complete severance of the sclera for a distance of 2 to 3 mm. at either end. The knife should be given a sawing motion to cut through the deeper lying tissues of the filtration angle, as far as possible, between the points of puncture and counter-puncture. This is the method of performing sclerotomy which, after trying several others, I have found gives the best results.

To recapitulate shortly :

Statistics of the results of glaucoma operations are apt to be misleading. Even the question as to whether a correct diagnosis between simple glaucoma and optic atrophy has been made in many cases included in such statistics, is open to doubt.

Iridectomy is capable of permanently arresting glaucoma at all stages and in whatever form it makes its appearance.

The longer the disease has lasted, irrespective altogether of the destruction which it has caused, the less likely is iridectomy to succeed.

Iridectomy should in all cases be done so soon as there is evidence of the disease being confirmed.

It should also always be tried as a first measure, however far the disease has advanced.

The operation should be followed up by treatment with miotics, and this treatment should be continued indefinitely.

In operating, the incision should be made with a keratome, and placed as peripherally as possible without leading to difficulties.

The amount of iris removed need not be as great as originally recommended by v. Graefe.

Cases in which iridectomy followed up by miotics fails should be treated by the formation of a cystoid cicatrix, the section into the eye being made so as to include the tissues behind the root of the iris.



