THE PRACTICAL SIGNIFICANCE OF GLAUCOMA INVESTIGATIONS

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SUMMARY

Before one can make a diagnosis of a borderline case, apart from repeated pressure readings at different times of the day, one must also chart the central and/or peripheral fields, and do a detailed gonioscopic examination.

Thereafter the various provocative and other tests described are essential in order to come to a firm conclusion as to whether or not the patient is suffering from glaucoma, and in which form.

The purpose of this article is to sort out the wealth of material on glaucoma investigations, and to present the more reliable and the more practical ones in a short, concise manner suitable for the practising ophthalmologist.

The importance of these tests is emphasized all the more since Leopold[1] and Shaffer[2] have stressed that ocular hypertension and glaucoma are not synonymous. The definition of glaucoma which I like is: 'An ophthalmic disease characterized by persistent or repeated elevation of the intra-ocular pressure *which eventually causes certain pathological changes in the affected eye*'.[3] This definition makes it clear that the raised intra-ocular pressure alone does not necessarily indicate the presence of glaucoma.

Our discussion will be confined to cases suspected of having glaucoma; clear-cut clinical cases are excluded. So often, there is a tendency for the ophthalmologist to prescribe miotics 'to be on the safe side'. Shaffer[2] warns against this practice, and in Johannesburg in 1968 he drew our attention to the unpleasant side-effects of many anti-glaucoma treatments. He says it is the responsibility of the ophthalmologist to do repeated and frequent periodic field charts and optic nerve tests, and if changes occur, only then must treatment be instituted. Leopold[1] concurs and says: 'An elevated pressure demands the patient to be regularly watched, but does not necessarily establish a diagnosis nor justify therapy'. Moreover, he says that in cases where treatment has been given, if there is a good response to pilocarpine without side-effects, treatment may be continued; but if the response is poor and the side-effects are great, the treatment must be terminated.

Leopold further reminds us that some eyes with a raised intra-ocular tension develop cupping, and some do not. And it is here that the tests for glaucoma assume such importance—if they are a help in order to diagnose whether a case definitely is or is not glaucoma, the patient might be spared a lifetime of unnecessary treatment or alternatively his sight might be saved. However, it should be remembered that the provocative tests are helpful, but not infallible.

Part of the reason for the latter is that there are unfortunately too many variables in the form of different instruments, and different standards set by different workers, to get a statistically significant appreciation of the same tests done by different observers.[4,5]

And so, from all this confusing mass of data let us try to find which tests are going to be the simplest, the most reliable, and the easiest for the patient and the ophthalmologist—the tests requiring the minimum in the way of apparatus, and which are not too time-consuming. I would first like to show the difficulties and deficiencies of the tests, and then evaluate them.

PREPARATION OF THE PATIENT AND INSTRUMENTS

It must always be remembered that behind the eye there lives a patient. You are testing a patient's eye, not just an isolated, detached organ. So in order to get accurate readings which require the co-operation of the patient, one must prepare him. Tell him what the examination is all about, and what he must expect. See that he is completely relaxed before tensions are measured. See that he is adequately anaesthetized before tension, gonioscopy or other procedures are undertaken. See that he does not squeeze.

Make sure your Schiotz tonometer is standardized. Before each patient, test your tonometer on the block. Before each session, test your applanation tonometer.

It is advisable for the same examiner to follow through with the same patient. Do not change your Schiotz tonometer halfway through a test. All these seemingly obvious remarks are necessary in order to avoid false tonometric readings. One sees that, not infrequently, patients are referred to the Glaucoma Clinic because of an ocular hypertension which we are unable to confirm.

(This may be a convenient point at which to make a plea for a tonometer-testing station in South Africa. A false reading on the tonometer scale may make all the difference between making a diagnosis of glaucoma (and therefore a life-sentence of treatment) or not. For example, a tonographic reading rising from 5 to 6·5 divisions on the scale gives a coefficient of outflow of 0·12, while a rise of 5 to 7·5 gives us a reading of C = 0·22—only 1 scale reading off the mark, but it makes all the difference in the resultant answer.)

EXAMINATION FOR GLAUCOMA

Before embarking on the special tests, it is important not to overlook the elementary and basic points in taking a history, including the complaint, the previous history and also the family history. Kolker and Becker[6] have now developed a computer to establish whether, based on the family history, a person is likely to develop steroid glaucoma, and this computer could be used to give an idea of a patient's chances of developing glaucoma, taking data (other than a steroid history) from the family history. Metz and his co-workers have used a computer in a glaucoma clinic to streamline the results and reduce the costs of keeping records.[7] One should inquire about headaches, haloes, general health and field defects.

Visual acuity and the refractive error should be checked. Complete a full physical examination of the eyes including AC-depth, disc, etc. Chart central and/or peripheral fields. Measure intra-ocular pressures—applanation, Schiotz (>21 mmHg found in 1:40 normal eyes; >24 mmHg found in 1:700 normal eyes).

We now proceed to the other examinations and tests:

Gonioscopy

The practice of gonioscopy is familiar to most of us.

Nevertheless, I would like to expand a little on this examination, because all too often one finds a very cryptic gonioscopic report in notes on patients, such as 'open-angle' or 'wide-angle'.

Let us classify our terminology at once. Most workers now agree to a classification of the adult primary glaucomas into (*a*) (chronic) simple glaucoma and (*b*) closed-angle glaucoma. The term 'wide-angle' is inappropriate since simple glaucoma could well occur with a narrow angle. 'Open-angle' is a confusing term because the angle in simple glaucoma is of no importance[8] and in angle-closure glaucoma, the angle may be open between attacks.[9]

So in describing the picture seen on gonioscopy we must be a little more explicit. We must certainly give an indication of the width of the angle, i.e. wide, medium, narrow, and whether open or closed. This terminology is defined as follows: wide—ciliary body band seen, in at least half its circumference; medium—ciliary body not visible; and narrow—trabeculae not seen.

An aid to see if the angle is closed. There will be no lateral displacement of the narrow beam of the slit lamp at the point where it forms an angle going from the inner surface of the corner towards the iris.[10] The 'on-off' test of Redmond Smith is also helpful.

Becker[11] grades the angles numerically thus:

	Grades
Wide, open angle	3 - 4
Narrow angle	2
Narrow angle, extreme	1
Narrow angle, complete or partial closure	0

Whichever classification one chooses, it is preferable to use one which is universally accepted, so that your findings can be understood by a reader elsewhere.

Next the following structures must be sought out:

(a) *On the anterior wall of the angle.* Line of Schwalbe; scleral spur; trabeculum; pigment—site and degree; and canal of Schlemm—empty or full.

(b) *Ciliary body.*

(c) *Pupil.* Note if it is round; posterior synechiae.

(d) *Iris.* 'Dandruff' flecks indicating exfoliation of lens capsule; iridodonesis; A - C depth; atrophy, abnormal pigmentation, colour of iris, root of iris, iris processes, peripheral anterior, synechia.

In the simple glaucoma there is no characteristic finding permitting a diagnosis solely on the gonioscopic appearance. Here the cause of a glaucoma is an increased resistance in the trabecular meshwork, so that one cannot see any pathological changes with a goniolens.

Importance of gonioscopy. Gonioscopy is of the utmost importance to give one: (*i*) an idea of the type of angle and of the glaucoma; (*ii*) this in turn helps to decide what further tests may be necessary, e.g. water-drinking, or dark-room, etc.; (*iii*) it may show up a hidden melanoma of the iris, a foreign body in the angle, etc.; (*iv*) it is essential in order to know whether it is permissible to prescribe the epinephrine drugs which are contraindicated in narrow angles.

I consider that no patient should have continued treatment for glaucoma unless a gonioscopic examination has been carried out.

Further Tests

(a) *Tests which are not commonly used* include tests of lability, jugular compression, caffeine, bulbar compression and postural tension differences, all of which are not reliable. The vasculat test is reliable but unpleasant while the hyaluronidase test is reliable but very painful.

(b) *Commonly used tests* include (*i*) the water-drinking test for narrow and wide angles: an increase of 8 - 9 mm is *probably* pathological, while an increase of 10 mm or more is more definitely pathological.[12]

(*ii*) Homatropine—a rise of 8 - 11 mm is *probably* pathological, while a rise of 12 mm is more definite.

(*iii*) Priscol (1 ml Priscol subconjunctivally)—11 - 13 mm rise probably pathological, 14 mm rise more definite.

(*iv*) Dark-room—10 mm after the first hour is pathological. This test is less reliable than the homatropine test but safer. At Groote Schuur Hospital we have taken the figure of 9 mm as positive in all these tests.

(*v*) Tonography—this has been found to be more reliable *after* the water-drinking test.

(*vi*) *Becker's Coefficient, Po/C.*[13] A coefficient of Po/C> 100 immediately after the water-drinking test was found in 94% with proved glaucoma, but in <2·5% in normal eyes. A coefficient of Po/C > 138 was found in 73% of glaucomatous eyes, and 0·15% in normal eyes.

'Unfortunately there are those who subsequently develop glaucoma who initially demonstrated a normal Po/C. This may be due to inadequate water absorption and haemodilution, errors in tonographic technique, or the intermittent nature of glaucoma in its early stages.'[13]

As mentioned earlier there is no fixed standardization of certain tests. For example, in the 4 minutes in which the weighted tonometer rests on the cornea, some measure it over the first 4 minutes, while others measure it from 3 to 7 minutes. Tests have been done with tonographic measurements for 15 or even 25 minutes without any improved results.

In the dark-room test, the period in the dark-room may be 1 hour, 1½ hours or 2 hours.

In order, therefore, to be consistent and to be able to compare results, it is imperative that each examiner decides clearly what the requirements of the tests are, and to keep to these requirements, and to state in his reports what the duration of his dark-room test is, and whether his tonography is C1-4 or C3-7.

Selection of Tests

In discussing the selection of tests at the 1954 Glaucoma Symposium[14] Leydhecker reiterated that the most reliable tests have the disadvantage that they are uncomfortable for the patient. The procedure he prefers is:

(a) *In narrow-angle glaucoma.* He starts with the homatropine test. If this is negative, he does a water-drinking test, and if this fails, he follows with the Priscol test. With this, he says, 82% of early cases can be detected.

(b) *In wide-angle glaucoma.* Four tests are done in this order: (*i*) Water-drinking test, (*ii*) Priscol, (*iii*) caffeine, and (*iv*) vasculat. With these he finds he gets 87% positive results.

We in Cape Town do only the water-drinking test followed by the tonographic tests for wide-angles and the dark-room or hydriatic tests for narrow-angles, followed immediately by the tonographic tests.

These provocative tests deal with only one symptom of glaucoma—hypertension. Because of the limits of our understanding of this disease complex, we must be thankful for anything that helps us in an early diagnosis which is so important for the prognosis of this condition.

At the Tutzing symposium Leydhecker[15] gives these figures for the reliability of the various tests:

Tonography—	50%	in an eye with normal initial tension.
Water-drinking—	17%	with normal initial tension.
Priscol—	53%	in general in glaucomas (not known in normal tensions).
Dark-room—	41%	in narrow-angle glaucoma with normal initial tension.
Homatropine—	46%	in narrow-angle glaucoma with normal initial tension.

Tonography. Tonography, like the other tests, must not be evaluated on its own, but in combination with all the clinical findings and other tests.

However, it is a most useful test, particularly if it gives a positive result. It may help to clinch a diagnosis of glaucoma when all the other findings are borderline. It is also of value in the narrow-angle glaucoma, helping to decide whether to do a peripheral iridectomy (if the outflow facility is good), or a drainage operation (if the outflow is poor). If there is an opaque lens, preventing disc observation and field charting, this tonography could be of help.

As is the case with the other tests, this test should be repeated where possible.

Water-drinking test. This is a useful test. It gives a good indication in most cases if the outflow is blocked beyond the trabeculum. If this test shows such an increase in the outflow resistance, iridectomy alone is not likely to help in narrow-angle glaucoma.

Dark-room test. We have not had a high incidence of positive results in clinically accepted angle-closure glaucomas. Leydhecker, however, has reported 41% positive results.

Homatropine test. Leydhecker finds a higher incidence in positive results than in the dark-room test. We agree with these findings, but extreme care must be taken that the patient's pupil is brought back to normal size before he is allowed to leave the surgery.

Lowe,[16] in a review on provocative tests, recommends tests be done on the fellow-eye in cases where there has been a definite angle-closure in one eye; on eyes suspected of having intermittent attacks; and in eyes which, although symptom-free, are found to have shallow ACs and narrow-angles on routine examination.

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