Current Practice

SPECIAL SENSES

Glaucoma

JOHN ROMANO,* F.R.C.S.

British Medical Journal, 1970, 2, 407-409

The past two or three decades have witnessed great strides in the possibilities of early detection and treatment of glaucoma. It remains, however, a tragically common cause of blindness. This is particularly true of the underdeveloped countries of the world, but it is still the third commonest cause of new blind registrations in Britain. Recent surveys carried out in many different countries have been startlingly in agreement: 1% to 2% of the entire population over the age of 40 is affected by glaucoma. Considered in numerical terms, particularly in this age of increased life-expectancy, the magnitude of the problem is evident. A general practitioner with an average-sized practice will come into contact with at least half a dozen potential cases a year.

Definition

Glaucoma can be defined as a disease-complex in which the cardinal feature is a rise of the intraocular pressure (the eye becomes too hard). As a result, the optic nerve is damaged with consequent loss of the visual field and eventual blindness. This definition will suffice for our purpose, though it is almost certainly an oversimplification. The exceptions are eyes that suffer damage of a typically glaucomatous nature without any obvious hypertension (so-called "low-tension glaucoma"), and others, conversely, that withstand with apparent unconcern an alarmingly high level of intraocular pressure ("ocular hypertension"). These are relatively rare, and the vulnerability of a given optic nerve to raised tension (possibly related to the efficiency of its blood-supply) is still a mystery. We can, therefore, adopt a simple mechanistic view: the pressure rises, suddenly in acute glaucoma and insidiously in chronic glaucoma, and the result is a special type of atrophy of the optic nerve.

We are concerned here with *primary* glaucoma—that is, occurring in otherwise healthy eyes. *Secondary glaucoma* may arise as a complication of disease within the eye itself—hypertensive uveitis (rise of pressure associated with an acute iridocyclitis) or an intraocular tumour; or outside the eye—a carotico-cavernous fistula with increase of ophthalmic venous pressure. Both the detection and the management of second-

dary glaucoma are related to the causal conditions and fall outside the scope of this discussion.

Mechanism

The mechanism of the rise of intraocular pressure in primary glaucoma is for practical purposes always due to obstruction to the outflow of aqueous from the eye, and almost never to excessive production of aqueous.

Physiology.—The normal intraocular pressure is 14-20 mm. Hg, as measured by modern methods (see later). Its level is remarkably constant for a given eye, and what determines it is the circulation of the aqueous humour, though at 200 μ l or so this represents only a small fraction of the intraocular contents. Formed behind the iris (see Fig. 1), the aqueous flows forwards through the pupil and fills the anterior chamber. Leaving it through the tiny yet crucial "angle of the anterior chamber" between iris and cornea, it reaches an intrascleral sinus (Schlemm's canal) and from it joins orbital veins outside the eye. The angle lies at the heart of the pathogenesis of glaucoma. Only recently has it been possible to visualize and evaluate the angle in life by the technique of gonioscopy (from gonio = angle) (Fig. 2). Since the advent of gonioscopy, glaucoma can be said to have come out of the dark ages, and we can now clearly define the two common forms of primary glaucoma.

In *acute glaucoma* the iris-tissue itself gets displaced and shuts off the angle. The usual way this happens is that the periphery of the iris becomes bowed forwards and is pressed against the cornea, preventing the aqueous from reaching the drainage angle. This produces a remarkably rapid build-up of pressure, which can reach 60-90 mm. in a couple of hours (Fig. 3). The precipitating factor is usually dilatation of the pupil. The angle is closed, and the modern term for this condition is *acute angle-closure glaucoma*. The older term of *congestive glaucoma* is deservedly being discarded: though the eye does become hyperaemic, congestion is a secondary phenomenon, occurring after the angle has closed mechanically.

Figure 1

Figure 2

Figure 3

* Consultant Ophthalmic Surgeon, Hillingdon Hospital Group.

Angle-closure occurs in eyes with a special configuration: a shallow anterior chamber and an iris that tends naturally to bow forwards. This is mainly seen in hypermetropes (long-sighted individuals) and particularly in old age, because the crystalline lens keeps growing and it tends to push the iris towards the cornea. If the attack is relieved outflow and pressure return to normal. After repeated episodes, however, permanent damage is produced, and the pressure remains raised.

In *chronic glaucoma* the angle remains open at all times, and is not distinguishable morphologically from a normal angle. It is, beyond any doubt, the site of increased resistance to outflow, but in spite of much recent work the exact mechanism remains a mystery.

The modern term for the condition, logically, is *open-angle glaucoma*. Here, the older term chronic simple glaucoma, hallowed by long usage, has been retained, but on the universal understanding that is used synonymously with "chronic (primary) open-angle glaucoma." It can occur in any type of eye with an angle of any depth.

It can be seen, therefore, that acute and chronic glaucoma are two distinct entities. They present a totally different symptomatology (see later), but have two things in common: they are both diseases of late middle age and old age, and there is strong evidence that both may be genetically transmitted, with the same type only, acute or chronic, running in any given family.

Natural History

In acute glaucoma, if the attack is unrelieved, the affected eye goes blind within a few days. As the peculiar configuration conducive to angle-closure is almost always bilateral, the fellow-eye is greatly at risk. About 80%-90% of second eyes develop an acute attack within five years. An uncontrolled attack in the second eye leads, of course, to complete and permanent blindness.

In chronic simple glaucoma the natural history is much less dramatic but no less sinister: scotomata (blind areas) appear unnoticed in the visual fields of both eyes. They progress until, in most cases, only the central area persists, but since this is the area of sharp vision nothing abnormal may be noticed even on routine checking of sight. All field-loss is irreversible, and eventually the tiny central patch of sight is snuffed out. The result is total blindness.

Investigation

An attack of *acute glaucoma* is practically self-evident and needs no special investigation. Between attacks, however, the eye may be quite normal, but gonioscopy will reveal an angle likely to close. Confirmation may be sought by provocative tests such as the dark-room test. The pressure is measured, the patient is left in the dark for an hour, and the pressure is assessed again. In susceptible eyes a considerable rise of pressure may occur. A mydriatic test is used in some clinics, but it is not as physiological as the darkness test and may be dangerous.

In *chronic glaucoma*, if the classical triad of signs (see Table) is present the diagnosis should present no problem to the ophthalmologist. Quite often, however, the pressure is not found to be convincingly raised, and the following investigations are necessary:

(1) Careful and periodic examination of the optic disc for *pallor*, due to a paucity of blood-vessels over the disc and to glial absorption, *excavation*, with a sharp edge to the "cup," and *dipping of the retinal vessels* as they enter the cup.

(2) Repeated measurement of the pressure (tonometry) on different days and at different times of the day (inpatient "phasing") may catch a fluctuating pressure at one of its peaks.

(3) Tonometry. The familiar Schiøtz tonometer, applied to the anaesthetized cornea with the patient supine, measures the distance a small plunger can indent the cornea. The Schiøtz tonometer weighs about 18 g., and this can lead to inaccuracy. It is being superseded by applanation tonometry, where the force necessary to flatten a small given area of cornea measures the intraocular tension (the force pressing on the eye in this case is only 1 g.).

(4) Gonioscopy will confirm that the angles are open (and often deep).

(5) Careful and repeated charting of the visual fields is of extreme importance in both diagnosis and follow-up. The

Diagnosis of the Glaucomas

Acute (angle-closure) glaucoma	Chronic (open-angle) glaucoma
HISTORY AND SYMPTOMS Often previous episodes, milder and passing off, consisting of: (1) Pain (often so severe as to cause vomiting or shock). (2) In a blood-shot eye. (3) With blurred vision in affected eye only. (4) "Haloes" (rainbow-hued circles seen around naked light sources, which usually occur in the evening (darkness) and pass off on sleeping (miosis in sleep).	Usually NONE, or only ill-defined difficulty with eyes. In advanced cases only, loss of field may be noticed ("knocking into objects, poor sideways view when driving" . . .) Silent loss of all vision in one eye may be noticed.
Family history of loss of sight in one or both eyes in middle or old age	
CARDINAL SIGNS OF A MANIFEST CASE (1) Red eye. (2) Poor vision in affected eye (may be extreme). (3) Pupil dilated and fixed (no light reflex). (4) Often dimly seen through a steamy cornea. (5) Shallow anterior chamber (pupil and iris appear "near the surface"). (6) Pressure very raised. Eye feels rock hard on digital palpation (and tender). <i>Any blurred, red and painful eye must arouse suspicion of acute glaucoma.</i>	CLASSICAL TRIAD IN NORMAL LOOKING EYE (1) Raised pressure: often to only 26-30 mm., so needs instrumental measurement. (2) Cupped optic disc (see later). (3) Field-loss of special pattern (must be confirmed by careful charting). The visual acuity is normal in all but the most advanced cases. <i>The disc is the only clue for suspecting glaucoma in a normal looking eye.</i>
DIFFERENTIAL DIAGNOSIS (1) Acute conjunctivitis: Usually bilateral, with discharge. Vision normal. Both pupils of same size and active. (2) Acute irido-cyclitis: Vision usually impaired. Pupil usually small. Iris often looks "muddy."	(1) Other causes of optic nerve atrophy. (2) Other causes of field-loss (e.g. hemianopic or quadrantic defects in lesions affecting optic pathways).

perimeter (peripheral field) and tangent screen (central field) are still widely used and are very valuable, and modern sophisticated methods are now available for a really searching examination of small defects.

(6) Provocative tests. In many cases all the above investigations are negative, and yet suspicion persists that chronic glaucoma is present. It is possible to provoke an eye into revealing its true glaucomatous nature by throwing, temporarily, a great strain on the outflow mechanism.

In the water drinking test the strain is a temporary, acute over-production of aqueous induced by drinking 1 litre of water within 5 minutes on an empty stomach (to encourage haemodilution). If the outflow facility is barely sufficient to cope with a normal trickle of aqueous, it will now be inadequate and the intraocular pressure will rise. A rise of 8-10 mm. Hg is considered significant.

In tonography the stress is in the form of an external force applied to the eyeball to expel the aqueous under pressure. The difference in volume of the globe (corresponding to the volume of aqueous expelled) is recorded electronically during a 4-minute period. The smaller the difference in volume the greater the likelihood of glaucoma. This test is of value both in the detection of early glaucoma and in the follow-up of treated cases.

Treatment

Acute Glaucoma

Bringing the ocular pressure down to a reasonable level is a matter of great urgency. Pending referral to the hospital eye department, especially if a delay of some hours is to be anticipated, the following measures should be taken by the practitioner whenever there is reasonable suspicion of acute angle closure.

(1) Guttae pilocarpine 2% every 5-10 minutes for an hour, then at half-hourly intervals. (This may contract the pupil, and pull the iris away from the angle.)

(2) Acetazolamide (Diamox) 500 mg. intramuscularly or even intravenously followed by 250 mg. orally every 6 hours. (This will depress aqueous formation.)

(3) Analgesics and sedatives (including morphine) if the pain is severe.

Even if the diagnosis is incorrect the above treatment, limited to a few hours, should not be unduly harmful, and it may save the eye.

When the patient is admitted to hospital these measures will be continued and if necessary intensified using eserine or other anticholinesterase drugs cautiously once or twice, and administering oral glycerol or setting up a urea or mannitol drip further to inhibit aqueous formation.

The eye usually settles fairly soon. Surgery may be carried out at this stage (it is always unwise to operate on a hard eye). The operation is a minor yet curative procedure—peripheral iridectomy—in which by cutting out a tiny portion of the iris ballooning forwards is prevented and the eye will be saved from further angle-closure attacks for life.

As to the fellow eye, the permanent use of a miotic will diminish the chances of an acute attack in the future, but only a peripheral iridectomy will abolish them. Many surgeons, particularly in the U.S.A., operate on both eyes at the same sitting.

Chronic Simple Glaucoma

Though many successful operations are performed every year for chronic glaucoma, the general tendency in the past few years has been towards conservative treatment. Against the theoretical elegance and practical advantage of per-

manently lowering the pressure by creating a new channel for aqueous outflow we must offset the risk of complications, particularly of delayed cataract, the eventual failure of a proportion of initially successful interventions, and finally, a disturbing persistence of field-loss in spite of normalization of the tension in many cases. It is increasingly accepted that surgery should be reserved for cases in which medical therapy fails, as evidenced by persistence of field loss with raised tension; or where it is unavailable as in underdeveloped countries; or where it is impractical, as with individuals who cannot be relied upon to instil eye-drops regularly.

Medical treatment will, in most cases, preserve useful vision for the rest of the patient's life, provided full use is made of the modern range of drugs. Pilocarpine drops, however, 0.5 to 4%, remain the mainstay of our attack, often alone. In the anticholinesterase group of drugs, apart from eserine, two recently introduced substances are now widely used—phospholine iodide 0.06-0.25% and demecarium bromide (Tosmilen) 0.25-0.50% are effective and relatively safe. Concentrated topical adrenaline, 1-2% has been found to produce a reliable lowering of pressure, and its action is additive to that of the miotics. Finally, the carbonic acid anhydrase inhibitors, which depress aqueous formation, often save the day in difficult cases.

"Drainage" operations aim at creating a permanent fistula in the sclera where it is covered by conjunctiva; the classical method, trephination, is being challenged by a simple scleral incision whose lips are prevented from healing by thermocautery or by a pillar of iris incarcerated between them as a wick. Among many other available techniques are those aimed at diminishing aqueous formation by partial destruction of the ciliary body through the sclera, by diathermy or, more recently, by cryoapplication.

Conclusion

General practitioners often hesitate to refer cases they suspect of being glaucomatous because of some degree of uncertainty about the diagnosis coupled with an unwillingness to burden the hospital service. There should be no hesitation with a condition as serious as glaucoma. I am sure all ophthalmologists would much prefer to have referred to them the odd unilateral conjunctivitis or pale or physiologically cupped disc than feel that cases of potentially blinding disease are being neglected.

TODAY'S DRUGS

With the help of expert contributors we print in this section notes on drugs in current use.

Pentazocine

For many years there has been a search for a powerful analgesic which would be free of side-effects and in particular one which would not give rise to drug dependence. When pentazocine was introduced in 1967 it seemed to provide the answer and has been widely used since then. However, as with all enthusiastically acclaimed drugs, it is now entering a second and more sceptical period of its life.

Pharmacology

Both pentazocine and phenazocine are benzmorphans and chemically related to morphine. When phenazocine was shown to be an effective analgesic an attempt was made to develop a specific antagonist. The result was pentazocine, and like nalorphine it was found to have both analgesic and antagonist

properties, the latter being much weaker. Weight-for-weight, its potency lies between that of codeine and morphine, though the therapeutic ratio is much the same indicating its equivalent effect to that of morphine when given in an optimum dose. Preparations used so far are of the racemic mixture, and 30 mg. gives approximately the same analgesic effect as 10 mg. morphine when given intramuscularly or subcutaneously. Almost all the analgesic (as well as the side-effect) activity lies in the laevo isomer.¹ When given by mouth pentazocine is about a third as effective and rather slower in action, having a peak effect between one and two hours. Parenterally the onset of its effect is similar to morphine, though its duration of action is slightly less.^{2,3} It has no anti-inflammatory or antipyretic activity.

Pentazocine is mildly sedative and may cause respiratory depression, though the latter is less marked than with morphine or phenoperidine.^{4,5} Unlike the other major analgesics it does not lower the blood pressure and may even cause it to rise.^{2,5} The incidence of nausea and vomiting is very similar