GLAUCOMA

PRACTICAL PROTOCOLS IN GLAUCOMA MANAGEMENT

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Glaucoma is a progressive optic neuropathy that results in structural changes in the optic nerve head and typical visual field defects that may lead to severe visual impairment or blindness.

This article gives highly practical perspective to the management of glaucoma. With dedicated time and staff, glaucoma specialty clinic can go a long way in better management of this disease. However, it is neither a substitute for clinical skills nor experience nor gaining knowledge on the subject.

INTRODUCTION

Glaucoma is a progressive optic neuropathy that results in structural changes in the optic nerve head and typical visual field defects that may lead to severe visual impairment or blindness. Glaucoma may arise secondary to other causes such as trauma, steroid therapy, retinal ischemia or inflammatory processes such as anterior uveitis. Most cases of glaucoma are, however, primary glaucoma—either open-angle glaucoma, or closed-angle glaucoma.

All ophthalmologists should manage glaucoma
Meticulous record keeping is the backbone of glaucoma management
Early detection is important. At the same time, over diagnosis should be avoided
One should not hesitate to consult, in a difficult case, more experienced colleague

Ten Commandments in glaucoma diagnosis are:
1. Asymmetry (of cup:disc ratio/ neuro-retinal rim thickness/ intraocular pressure (IOP)) is the hallmark of glaucoma
2. Too much asymmetry in the above parameters/unilaterality is hallmark of secondary glaucoma. Unilateral glaucoma is secondary unless proved otherwise.
3. Disc size is of immense importance in the assessment of glaucomatous damage. A cup of 0.8 may be normal for a large disc and 0.2 is possible in a patient of glaucoma in a small disc.
4. Assessment of Retinal nerve fibre layer (RNFL) is best done in red free photograph of fundus and its clinical assessment may often be deceptive.
5. The gold standard instrument for measurement of IOP in cases of glaucoma is Goldmann applanation tonometry (GAT). Non contact tonometry can be used as a screening tool. Tonopen is good for scarred/irregular corneas and Dynamic Contour Tonometry for post-refractive surgery tonometry. Rebound tonometry can be used for pediatric patients. However, none of these instruments are mandatory except GAT plus any one instrument with which IOP can be measured in supine position (Perkins/Tonopen or Schiotz in that order).
6. Gonioscopy is a tool for differentiation of open and closed angles and can diagnose congenital defects, signs of past inflammation, angle recession, growths, neo-vascularisation etc.
7. Assessment of amount of damage is done by automated field analysis repeatedly done by same machine using same program. Imaging is required only in selected cases or for research.
8. All field defects do not mean a defect in eye and all field defects due to eye disease are not glaucomatous. All cuppings are not pathological and all pathological cuppings are not glaucoma. The test for glaucoma diagnosis is demonstration of progression over a period of time.
9. Normal tension glaucoma (NTG) is a diagnosis of exclusion. It is not very common, at least in India, although western studies report otherwise. Diurnal variation test over 24 hours and demonstration of progression are required to be able to diagnose NTG. Possibility of died down glaucoma should be considered.
10. The only confirmatory sign of glaucoma is demonstration of progression - whether by clinical examination or by investigations.

PRE GLAUCOMA-CLINIC ASSESSMENT

Patients with borderline suspicion of glaucoma, and who are not on treatment, may first undergo a diurnal variation test and Humphrey’s visual field testing and followed by an appointment for glaucoma clinic. Obvious cases of glaucoma are referred to Glaucoma clinic immediately along with a latest visual field record. Infantile glaucoma is to be treated as emergency.

WORKUP IN GLAUCOMA CLINIC

On the first visit, demographic records of the patient, detailed history and standard ophthalmological examination including Applanation tonometry (AT) and gonioscopy are performed. Central corneal thickness (CCT) is measured using ultrasonic pachymeter. The order of examination remains...
GLAUCOMA

ANTERIOR SEGMENT EXAMINATION

During the anterior segment examination, it is important to note the pupillary ruff, since its atrophy may signify previous acute or sub-acute attacks of angle closure. Presence of pigment on the lens/corneal endothelium or posterior synechiae signifies previous inflammation. Pseudoxfoliative material is also specially looked for.

All unilateral glaucomas, except for very early cases, should be considered secondary and all efforts be made to look for the cause. Looking for pupillary ruff changes with special care is essential in PACG suspects.

GONIOSCOPY

For all cases, Gonioscopy is to be performed. Initial examination is done with a beam of low height without encroaching pupillary margin to assess angle width. However, beam is later made brighter and height increased to see opening of angle and also to assess details of the angle. The preferred gonioscope is two mirror Goldmann type with the use of 2% methylcellulose as coupling agent. Manipulation gonioscopy and over the hill viewing of angle is essential part of this investigation. Indentation gonioscopy is performed using 4 mirror Sussaman/Zeiss gonioscope to differentiate between appositional and synechial closure. Ensure that no pressure is applied on cornea while doing Gonioscopy otherwise corneal folds will obscure the view. The record of findings includes the structure seen, degree of angle recession, if present, evidence of past closure in the form of peripheral anterior synechiae or pigment clumps, abnormal vascularisation or any adventitious structures. Contour of iris, like forward bowing, if present, is also noted. Effort is made to assess if the angles are occludable. In cases of developmental or juvenile glaucoma, degree of angle covered with the sheet of iris is specified.

PRIMARY ANGLE CLOSURE DISEASE

Primary angle closure disease (PACD) is divided into Primary angle closure suspect (PACS), Primary angle closure (PAC) or Primary angle closure glaucoma (PACG) based on the following criteria. On gonioscopy, eyes with narrow or occludable angles are defined as angle structures not visible beyond anterior trabecular meshwork.

a. Primary angle closure suspect (PACS):
No evidence of past angle closure, normal intraocular pressure and no disc or field changes. Fellow eyes of all patients who have gone into acute attack or are suffering from chronic angle closure and do not fall in category b or c, fall in this category.

b. Primary angle closure (PAC):
Evidence of past angle closure or raised intraocular pressure or both but no disc or field changes

c. Primary angle closure glaucoma (PACG):
Evidence of past angle closure attack and/or raised intraocular pressure and presence of disc and/or field changes.

Protocol for laser iridotomy

One needs to remember that angle closure glaucoma is almost as common as open angle among Indians. Additionally, this is far more disabling than POAG and results of surgery are also poor. Therefore, need of looking for subtle signs of angle closure cannot be over-emphasized. Laser PI being a very innocuous procedure, it is better to err on the side of doing this for PACG rather than missing the opportunity of a curative management for future PACD.

Indications of Laser iridotomy in PACD

- All PAC and PACG patients
- Fellow eyes of patients with acute attack or PACG
- Critically narrow angles- <10°/appositional closure/or only Schwalbe’s line visible
- Symptomatic patients-evening low grade brow aches
- Pupillary ruff changes
- Glaumomflecken
- Cannot come for follow up
- Need for frequent dilatations- e.g. for retinal diseases

Selection of Location

1. The most preferred location is supero-nasal because:
   i. Less likely to cause macular damage by the laser.
   ii. Less likely to result in lenticular damage in case side port is created during any future surgery.
   iii. It is covered with upper lid hence no diplopia.

   As far as radial location is concerned, it is best performed at the junction of peripheral one-third and central two-thirds.

   Extreme peripheral location should be avoided because:
   i. Failure is common due to poor view.
   ii. May result in iridodialysis.
   iii. Assessment of its patency may become difficult after effect of pilocarpine is over.

   Central location should be avoided since:
   i. It can cause damage to collaret.
   ii. Frequently closes down soon after achieving patency.
iii. Can cause diplopia.

2. Presence of crypts: The presence of crypts that takes priority for deciding the location even if it happens to be inferior or extreme peripheral. However, it is never to be performed in the area of collaret. Thin areas in collarets are not crypts. Iris here is boggy and PI will close immediately after penetration.

3. Amount of energy/ mode:
Amount of YAG energy is fixed from two 2-5 mJ per pulse depending on the available machine. In case of very thick iris or absent iris crypts, burst mode with two pulses/ shot may be considered. In the absence of iris crypts, argon laser shots are applied in drumstick manner to stretch iris at mid periphery (Figure 1,2). Once this is done, YAG energy is applied in the central stretched iris using double shot (burst mode). The settings are spot size 100 μ, duration 100 msec, energy 100-250 mJ.

4. Total number of shots/ energy: In the presence of crypts, generally patency is achieved using single pulse. Few more shots may be given to obtain optimum size of the opening (1-2 mm- minimum size 0.75 mm). However two pulses/ shot may be considered in the absence of crypts. One should not exceed maximum total energy of 40-80 mJ, depending on the machine, in one sitting.

One may need to abandon the procedure if there is hemorrhage, iris chaffing or too much pigment release. Once iris chaffing starts one should select a new location or try after sometime (as early as half an hour) or next day because all next shots will result in chaffing only and no penetration will take place.

Repeating the Laser Iridotomy: In case of excessive pigment release or minor bleeding, iridotomy can be tried after 30 minutes. In case of haemorrhage (Figure 3) or chaffing, it can be repeated 1-3 days later, after giving frequent topical steroids. Long delay in the hope of controlling inflammation before repeat iridotomy may lead to formation of posterior synechiae or peripheral anterior synechiae apart from inconvenience.

After a successful Laser iridotomy, patient is further managed as a case of open angle glaucoma with a few exceptions.

Procedure of PI

- At least two readings of applplanation tonometry are recorded using sterile precautions, before performing Nd:YAG laser iridotomy.

- Pilocarpine 2% eye drops are instilled every fifteen minutes, four times, starting one hour before iridotomy.
- One drop of Proparacaine 0.5% eye drop is used as a local anaesthetic.
- Abraham iridotomy lens is used along with 2% methylcellulose as coupling agent. The use of lens stabilizes the eye and improves cooperation of patient as well as focus of laser beam.
- Patient is examined for the presence or absence of iris crypts.
- It is the presence or absence of crypts and not the iris thickness that determines the amount of energy required. If crypts are present, less energy is required.
- If crypts are absent, we use the drumstick technique of sequential double frequency YAG followed by YAG laser. Generally, a single shot is sufficient for penetration. It is followed by 2-3 shots for extension.
- Patency is considered to be achieved when a gush of aqueous flows out from behind, clear red glow is seen without iris strands or ciliary processes are seen through the iridotomy.

Post Laser iridotomy

Most glaucoma patients are steroid responders. Post laser, a steroid with low potential for steroid induced glaucoma like loteprednol eye drops is given 3-4 times a day, depending on the energy used, for a week.

In case less than 40 mJ YAG laser energy is used, no ocular hypotensive agent is generally needed except in very high risk cases. However, it is good practice to check IOP 1-2 hours following PI. α agonists are the most effective ocular hypotensives for post laser spikes. Within this group, apraclonidine was considered the best. However, it is no more available in Indian market. Therefore, the best drug available in India is Brimonidine. If high energy is required for laser iridotomy, this drug may be instilled three times a day for a week.

Pilocarpine 2% BD for five days is given to keep iris stretched to maintain patency. It is given for five days so that its effect is over at the one week examination. Patient is called for evaluation after a week and patency of the iridotomy is confirmed. If PI is closed, it is reopened.

> 40 mJ to avoid ocular hypotensive drugs
- Patency is achieved when a gush of aqueous flows out
- Use loteprednol 3-4 times/day post laser X 7 days and pilocarpine BD x 5 days
assessed and IOP measured. If iridotomy is patent, gonioscopy is performed to assess how much the angle has opened and for better assessment of PAS. The patient is dilated with eye drop Tropicamide 1% and mid dilated IOP is measured. Phenylephrine is avoided because, first, it causes wide dilatation whereas maximum IOP rise takes place during mid- dilatation; secondly, there is no antidote if patient goes into acute attack and thirdly, dilatation is very fast but constriction is slow, thus, patient may develop acute attack after leaving the clinic. Routine dilated ophthalmological examination and disc evaluation are then carried out.

In case IOP rises on dilatation of pupil, then it is considered as a case of plateau iris syndrome and patient is kept on long term pilocarpine or is taken up for trabeculotomy. The most important criterion to decide in favour of surgery is presence of definite field defects and long term pilocarpine is absence of field defects. The purpose of PI is to bypass pupil in case of papillary block and all cases of PACD are not exclusively due to pupillary block. In case of angle crowding as the mechanism of PACD or extensive PAS, PI will not be effective.

In case IOP does not rise on dilatation of pupil, further management is like a case of POAG.

In case angles open up following PI and IOP remains within normal range without disc and field changes or in cases of PACS including fellow eyes of eyes with PACG, disease is taken as cured. However, three monthly assessments in the beginning may be progressively reduced to yearly follow up which is generally done lifelong. The minimum work up includes VA, IOP measurement and undilated fundus examination every visit along with at least yearly dilated examination, gonioscopy, and field charting.

**Management of acute angle closure attack**

If a patient presents in an acute attack of primary angle closure, we start intravenous mannitol (hyperosmotic agent) immediately. Once intraocular pressure falls down to 40 mm Hg, topical pilocarpine 2% is instilled every thirty minutes for four times or till pupil constricts, followed by four hourly for one day. Oral acetazolamide one tablet 6 hourly and timolol 0.5% eye drops BD are started and patient is called next day.

Brimonidine can increase hyperemia, dorzolamide can cause ciliary body congestion and PG analogous can cause breakdown of blood aqueous barrier and, thus, fall lower in the preference of their use. Topical steroids are instilled four times/ day to reduce associated inflammation.

Periphereal iridotomy is done the next day once the cornea is clear. Oral acetazolamide is withdrawn depending on IOP and patient is started on routine treatment.

In occasional cases, the pupil does not constrict with pilocarpine eye drops and PI is difficult to perform as cornea is edematous and iris boggy. Carefully done paracentesis may help in making cornea clearer and PI possible. The threshold for lens extraction is very low in these cases. In case a mild cataract is present, it can be cleared and PI possible. The other option in these situations. However the results in Indian eyes have not been reported to be satisfactory with this method hence it is not performed in our centre.

**ANGLES OPEN ON GONIOSCOPY**

When the angles are found to be open, intraocular pressure is high, typical disc changes are observed and no cause of secondary glaucoma can be detected, the presence of 'Primary Open Angle Glaucoma' (POAG) is considered. Perform a visual field examination followed by assessment of pressure at which loss of nerve fibres has taken place. The maximum IOP ever reached and the period for which the disease has been present is determined by history taking, careful scrutiny of old records and doing a Diurnal Variation.

**Diurnal Variation (DV) off Drugs is done to record (a) the maximum IOP (b) range of IOP and (c) time of maximum IOP. Diurnal variation on drugs is done to see the diurnal efficacy of the drugs being used**

**Indications of Diurnal Variation**

1. To confirm diagnosis/ collect baseline information: DV off drugs in patients with
   - Ocular hypertension (OHT) – to know the maximum IOP levels to decide whether to treat or observe.
   - It is generally accepted that patients with IOP >27 should be treated even if no disc and/or field changes attributable to high IOP can be demonstrated.
   - NTG (Normal Tension Glaucoma) suspects: in patients with glaucomatous damage but IOP recorded normal during office hours (to avoid diagnosis of NTG for patients of POAG with peaks of high IOP outside office hours).
   - When IOP is borderline (21-24 mm Hg), with or without evidence of glaucomatous damage, to differentiate between Ocular Hypertension and POAG and to decide whether to treat or not.
   - Damage at low pressure i.e. in cases of moderate/ advanced glaucomatous damage with high IOP but not high enough to explain the loss.

2. For efficacy of therapy, also known as diurnal control, helps to assess if target pressure remains achieved round the clock. This is helpful in advanced cases and when disc/ field changes progress despite good IOP control during office hours. The findings can be compared with DV done before starting treatment.

**Diurnal variation is not indicated in angle closure glaucoma cases unless a mixed mechanism is suspected**

3. Others: DV also gives us the following advantages:
   - It may reveal the peak IOP levels, the time of the day when the peak occurs and the range of IOP fluctuation during the examination period-all have implications on planning the treatment, including timing of instillation of drugs.
   - In OHT- if IOP >27, we start therapy irrespective of the corneal thickness. If poor follow up is expected, we start therapy even at 25 mmHg and above unless corneal thickness is >600μ.
   - Pre-perimetric Glaucoma- we start therapy if high IOP readings are seen in DV along with defects found on imaging. It is very difficult to decide to start therapy with RNFL defects demonstrated on imaging alone.

**Central Corneal Thickness**

Next step in the work up is to measure CCT. The preferred instrument is contact type ultrasonic pachymeter. It requires same precautions for its use as those for GAT.
CCT is measured because the IOP is falsely recorded higher in thicker corneas and lower in thinner corneas. Corneal thickness of 500 microns to 550 microns is taken as normal.

In case the thickness is greater or lesser than this range, a correction factor is applied to the IOP. Taking the baseline as 540 microns, the correction factor is calculated as 1 mm Hg of pressure for every 14 microns from baseline. This factor is subtracted from the measured IOP in case of thicker corneas and is added in case of thinner corneas.

The corrected IOP is taken as the reference value for deciding the target IOP for a particular patient and also for those with ocular hypertension.

**Provocative tests**

These have a limited role and are indicated only in few cases. Various tests can be:

a.) Water drinking test (for POAG)
   - Patient is asked to come empty stomach and made to drink 1L of water
   - IOP is checked every 15-20 min for 1-2 hours
   - Rise of more than 6-8mm Hg is significant

b.) Dark room test (for PACD)
   - Patient is made to sit in a dark room for 60-90 min
   - IOP is recorded in dim illumination
   - Rise of 8mm Hg or more is suggestive of narrow angle glaucoma

c.) Prone position test (for PACD)
   i. Patient is made to lie down in prone position for 30-45 min
   ii. Rise of IOP more than 8-10mm Hg is positive
   Combined Prone and Darkroom test (for PACD)
   iii. Prone test in dark room done for 30-45 min
   iv. Rise of IOP to 10mm Hg more than baseline is taken as positive

**ARRIVING AT A DIAGNOSIS**

After determining the corrected IOP and the status of angles, patients are dilated for fundus examination and details of optic disc are recorded diagrammatically along with the optic disc size.

The Humphrey’s visual fields, which the patient usually undergoes prior to the first Glaucoma clinic visit are interpreted and correlated with the examination findings.

Based on the disc findings, the baseline IOP of the patient, field changes and life expectancy of the patient, a target IOP is decided and further management is decided accordingly.

**Patient guidance**

Individualize the management considering the patient’s socio-economic status, daily work schedule, systemic status and drug allergies.

Inform the side effects of the drugs being prescribed. Communication about the present status/prognosis and general information about the disease is an important part of the management. It is a lifelong disease and development of a bond between patient and doctor goes a long way.

The lifestyle changes and how to apply eye drops are also explained. The lifestyle changes include avoiding liquids in quantity of 500 ml or more in a short interval especially empty stomach, avoiding tobacco, exercises involving total inversion of body like ‘sheersh aasan’, ‘kapaal bhaati’ pranayama and tight neck ties. All the patients are encouraged to do regular exercise and to have their first-degree relatives examined.

**Follow up of patients**

Glaucoma is not only an under-diagnosed but also an over-diagnosed disease. If patient appears to have been unnecessarily treated, medicines are stopped and patient is followed up at 2-4 weeks, then 2 months and then 3-4 months with IOP measurement and six monthly fields. If no rise in IOP or sign of progression is detected over one year, then the patient is followed up every 6-12 monthly for a total of 5-6 years when he can be declared as not having glaucoma.

Stable patient, in whom a medication has been altered, should routinely be seen within approximately one month of the change.

Patients with stable disease in whom satisfactory IOP control has been achieved should be followed at three to four months’ interval.

Stable patients with less severe disease may be followed up with longer intervals, maybe up to six months.

**Work up during follow up visits**

- Baseline visual fields
- Target pressure to be highlighted for every patient and should be revised periodically
- BCVA and Applanation Tonometry
- Dilated fundus examinations to be done every 3-4 months but at least once every year
- Visual fields to be repeated at least once a year Six monthly fields are done in patients with evidence of progression/advanced disease/disease requiring confirmation/OHT patients not on treatment.
- Gonioscopy should be repeated in case there is unexplained rise of IOP and yearly in cases of angle closure glaucoma
- Yearly disc photography
- A patient with sudden decrease in BCVA look for cause- like uveitis, neovascularisation of iris, cataract, retinal pathologies etc.
- A patient with sudden rise of IOP-rule out secondary glaucoma and perform gonioscopy to look for additional factors.

But for the constraint of space, these protocols may be made far more exhaustive than presented here. We leave that job to the individual heads of glaucoma practice in each individual institution/group practice.

**REFERENCES**


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