

Erroneous assumption of ocular hypertension in patients with elevated intraocular pressure

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Purpose: To determine the proportion of erroneously assumed ocular hypertension (OHT) among referred patients of elevated intraocular pressure (IOP) seen in glaucoma clinic of a teaching hospital in Northern India. **Methods:** Retrospective review of case records of referred, diagnosed patients of OHT or unspecified glaucoma seen between January 2019 and March 2020. Using an algorithmic clinical approach, including gonioscopy, Goldmann applanation tonometry (GAT), and pachymetry, underlying cause for elevated-IOP was amended and proportion of erroneously assumed OHT was calculated. **Results:** Of 276 patients diagnosed either as OHT or unspecified glaucoma before being seen at our glaucoma clinic, 44 (16%) had IOP within normal range (10–21 mmHg) on GAT. In 97 (35%) cases elevated-IOP was associated with angle closure. The central corneal thickness (CCT) was >550 μ m in 39 (14%) patients with elevated-IOP. The proportion of erroneously assumed OHT was 70% in this study. **Conclusion:** The elevated-IOP does not imply with OHT unless evident through comprehensive clinical examination and appropriate investigations.

Key words: Elevated intraocular pressure, erroneous diagnosis, ocular hypertension, primary angle closure

Access this article online

Website:

www.ijo.in

DOI:

10.4103/ijo.IJO_938_21

Quick Response Code:



Diagnosis of glaucoma is centered on characteristic structural and functional damage to optic nerve.^[1] The elevated intraocular pressure (IOP) is an important and modifiable risk factor for most types of glaucoma.^[2] The distribution of normal IOP in general population ranges between 11 and 21 mm Hg.^[3] An IOP more than 21 mmHg is generally considered as elevated.^[4] Elevated-IOP is the one of clinching finding in clinical practice, which prompts diagnosis of glaucoma.^[5,6] Diverse mechanism underlies for elevation of IOP, involving both open and closed angles. Elevated-IOP in presence of open angles and without discernible changes in optic nerve head (ONH) and/or visual field (VF) is defined as ocular hypertension (OHT).^[6] There may be an identifiable cause for elevated-IOP in presence of open angles, conventionally called secondary glaucoma, even in the absence of characteristic changes of ONH.^[2] However, elevated-IOP in settings of angle closure (appositional or synechial) without ONH changes and in absence of any identifiable cause for angle closure is known as primary angle closure (PAC).^[7] The natural clinical course and management of two conditions, OHT and PAC, is different.^[7] Furthermore, IOP may be recorded "elevated" spuriously on account of factors affecting technique of tonometry like central corneal thickness (CCT).^[8] Hence, without acknowledging the determinants of IOP measurement and understanding the underlying mechanism of elevated-IOP, erroneous diagnosis may not be avoidable in clinical practice.^[9,10] This study aimed to know proportion of patients in which elevated-IOP is erroneously assumed as OHT, and to know the underlying cause of elevated-IOP in a hospital-based setting.

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Received: 20-Apr-2021

Revision: 31-Aug-2021

Accepted: 06-Oct-2021

Published: 27-Jan-2022

Methods

This retrospective study was conducted in a teaching hospital located in Western Haryana of Northern India. The study adhered to the tenets of the Declaration of Helsinki and was approved by the institutional ethical committee. An overview of the study methodology is shown in Fig. 1.

The study included case records of patients who presented to our glaucoma clinic with diagnosis of OHT or unspecified glaucoma between January 2019 and March 2020. We included referred patients, from outside as well our own general outpatient department, and those presented themselves for second opinion after being diagnosed elsewhere. The inclusion criteria were IOP \geq 22 mm Hg in one or both eyes, clinically normal ONH on slit lamp biomicroscopy, and no structural and/or functional changes of retinal nerve fibre layer (RNFL). The ONH was considered healthy if vertical cup-disc ratio (VCDR) was <0.6 or asymmetry between two eyes was within 0.2, no focal or diffuse neuro-retinal rim (NRR) thinning, and absence of any RNFL defect.

All patients underwent comprehensive ocular examination including Snellen visual acuity, the Goldman applanation tonometry (L-5110, Inami, Tokyo, Japan), Posner four-mirror dim lit room indentation gonioscopy, pachymetry (REM 3000, Tomey Corporation, Japan), and dilated slit lamp

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Cite this article as: Rewri P, Ali W. Erroneous assumption of ocular hypertension in patients with elevated intraocular pressure. Indian J Ophthalmol 2022;70:564-8.

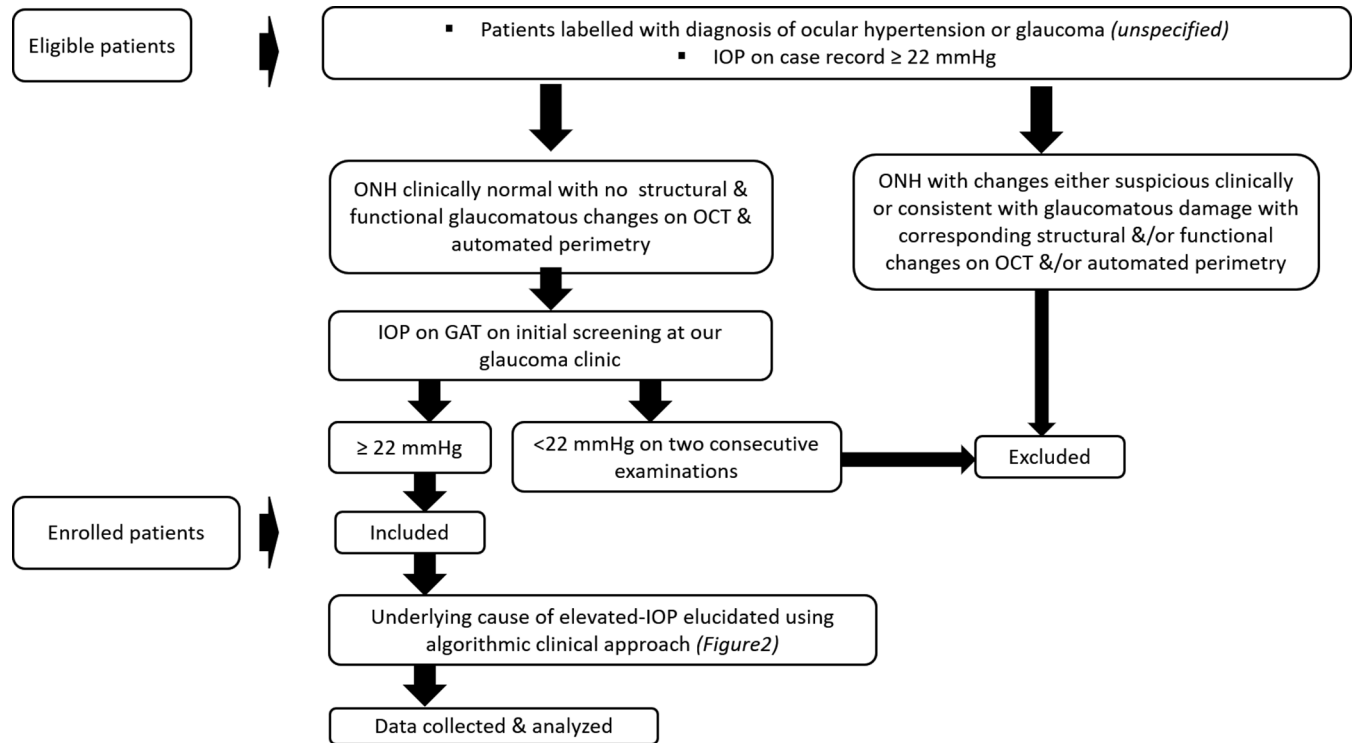


Figure 1: Flowchart depicting overview of study

biomicroscopic examination using 90 D lens. In patients, already on topical IOP-lowering medications, drops were stopped after initial examination, and re-evaluation was done after a washout period of 2 weeks. If GAT-IOP reading was less than 22 mm Hg at least on two visits, 1 week apart at different office hours, this was labelled as IOP within normal statistical range. In all patients with GAT-IOP reading ≥ 22 mmHg, baseline disc photo (Digital Retina Camera CX-1, Canon Inc, Japan), RNFL-posterior optical coherence topography (RS-330, Nidek Co Ltd, Japan), and standard automated perimetry (Humphrey Field Analyzer 720i; Carl Zeiss Meditec, Germany) were obtained. Patients were advised optimum treatment based on clinical diagnosis for elevated-IOP, which included observation, drug therapy, and Nd-YAG laser peripheral iridectomy (LPI).

In this study we applied an algorithmic clinical approach to elucidate underlying probable mechanism of elevated-IOP [Fig. 2]. Table 1 reads the criteria and definitions used in this study to categorize the elevated-IOP under different diagnostic categories. We put patients with GAT-IOP ≥ 22 mmHg and CCT > 550 μm in a separate category of "probable OHT".

The data was entered in excel spreadsheet (Microsoft Cooperation; USA) and descriptive analysis was done. The proportion of cases erroneously assumed to be of OHT on referral was calculated.

Results

We found 276 records eligible for this review. In 263 (95%) referral documents, the IOP was measured using tonometer other than GAT, either non-contact tonometer (NCT) or Schiottz tonometer. Gonioscopy findings were available in seven (2.5%) and CCT in 64 (23%) of clinical records. Sixty-one (22%) patients were on IOP-lowering topical drops.

Table 1: Criteria and definitions applied in this study to sub-group patients

Elevated-IOP (ELEVATED-IOP): IOP ≥ 22 mmHg with applanation tonometer in one or both eyes irrespective of angle status and CCT.

Ocular hypertension (OHT): IOP ≥ 22 mmHg with applanation tonometer in one or both eyes, in presence of un-indented open angle and CCT < 550 μm and absence of any secondary cause.

Secondary OHT: IOP ≥ 22 mmHg with applanation tonometer in one or both eyes, in presence of un-indented open angle and CCT < 550 μm in presence of any secondary cause (e.g., exfoliation, steroid usage, etc.)

Probable-OHT: IOP ≥ 22 mmHg with applanation tonometer in one or both eyes, in presence of un-indented open angle and CCT ≥ 550 μm and absence of any secondary cause.

Primary angle closure (PAC): IOP ≥ 22 mmHg with applanation tonometer in one or both eyes, in presence of occludable angles or PAS on gonioscopy, irrespective of CCT.

On initial evaluation at glaucoma clinic, the IOP measured by GAT was < 22 mm Hg in 44 (16%) patients, on at least two occasions. The mean \pm SD CCT in these eyes was 523 ± 16 μm . Seven (2.5%) of these patients had appositional angle closure, and were labelled as primary angle closure suspect (PACS). The IOP by GAT was ≥ 22 mmHg in 232 (84%) patients. Of these, 135 (58%) patients had open angles on gonioscopy. Thirty-nine (14%) patients had IOP ≥ 22 mmHg and CCT > 550 (mean \pm SD: 566 ± 33) μm , whereas 83 (30%) patients had IOP ≥ 22 mmHg and CCT ≤ 550 μm . In the latter group, mean \pm SD IOP was 25 ± 3 mmHg and CCT was 523 ± 33 μm . Secondary OHT was seen in 13 (5%) patients, which included patients with steroid response (n = 6), pseudo-exfoliation (n = 5), and pigment dispersion syndrome (n = 2).

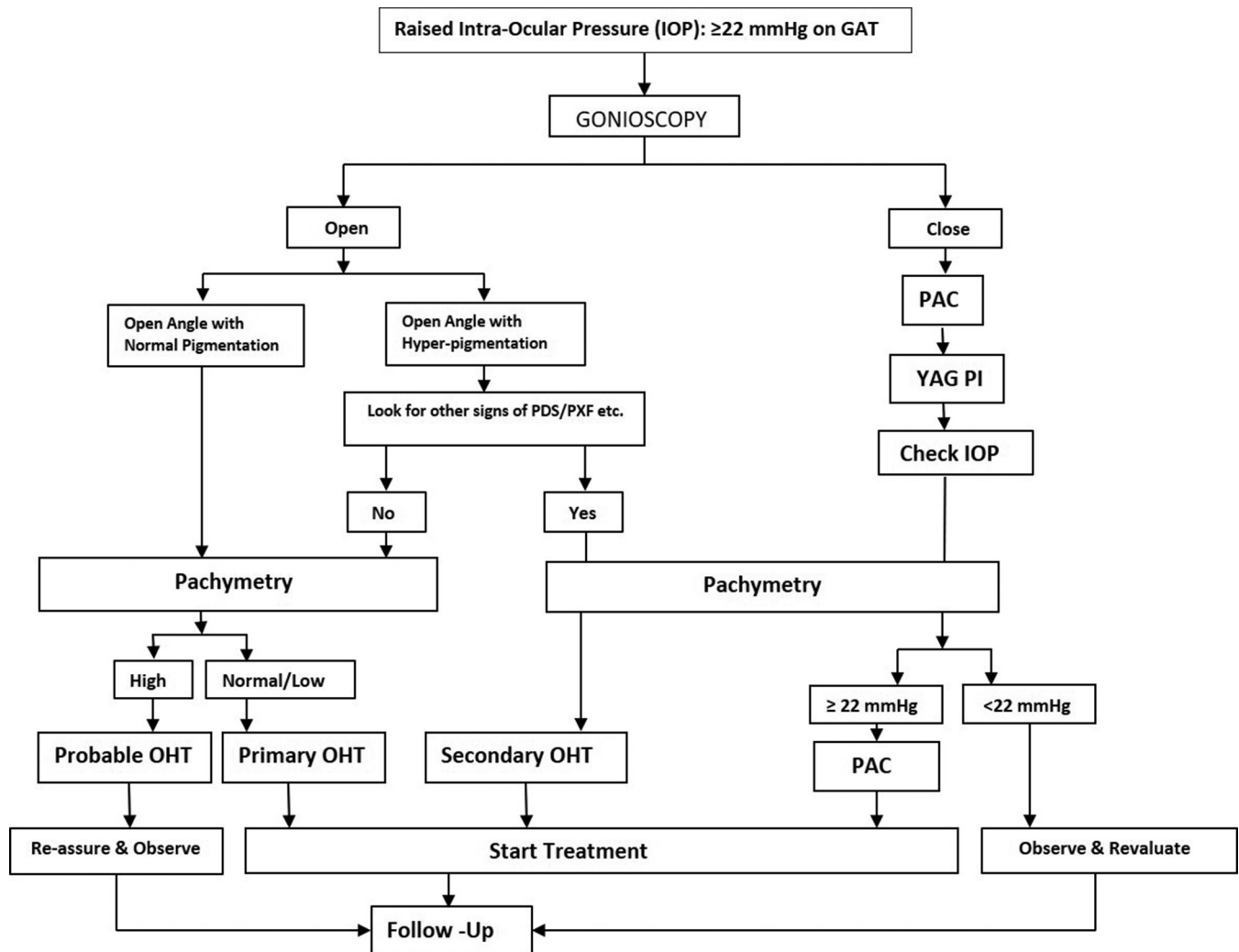


Figure 2: Algorithm applied in this study to approach a patient of elevated-IOP (≥ 22 mmHg on GAT)

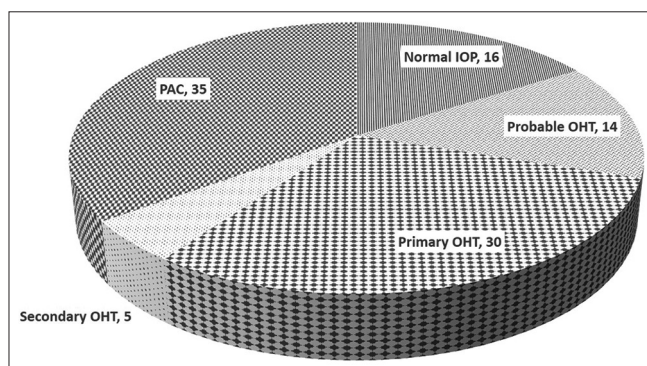


Figure 3: Proportion of diagnostic categories of all referred patients labelled as ocular hypertension. The proportion is in terms of total referral ($n = 276$)

Elevated-IOP by GAT was associated with angle closure in 97 (35%) patients [Fig. 3]. The mean \pm SD IOP was 32 ± 5 mmHg and CCT was 518 ± 30 μ m. Peripheral anterior synechiae (PAS) were noted in 131 eyes of 76 patients, and 21 patients had appositional angle closure. Twenty-nine (10%) of angle closure patients were on IOP-lowering topical drops, and none had

received YAG peripheral iridectomy or parasympathomimetic drug. All these patients with PAC underwent LPI at our glaucoma clinic. The CCT was >550 μ m in 14 (14%) of angle closure patients.

The erroneous assumption of OHT was noted in 70% cases of elevated-IOP on tonometry other than GAT; of these 104 (37%) had angle closure.

Discussion

The recommended comprehensive clinical evaluation for glaucomatous conditions includes IOP measurement, gonioscopy, and CCT among other things.^[11,12] However, in this study, we found that this practice was missing in most of the referral documents. There might be several factors precluding comprehensive evaluation of every patient in outpatient department, including overburdened clinical practice. Under such circumstances, at least patients with elevated-IOP on screening with NCT or Schiøtz tonometer should selectively be subjected to GAT.^[12,13] Lack of standardized care, substituting applanation tonometry, and excluding gonioscopy in routine clinical practice has been reported.^[14] In this retrospective study, we noticed that whenever elevated-IOP was recorded

on screening with tonometers other than GAT, it was neither re-assessed nor confirmed on applanation tonometer. This contributed to erroneous labelling of elevated-IOP in 16% of cases. The IOP between 10 and 21 mmHg is often used as normal range in clinical practice, without giving consideration to age, ethnicity, type of tonometer, and corneal bio-characteristics. The limit of agreement of different types of tonometers has been found to be large in a study comparing different techniques of IOP measurement.^[15]

Gonioscopy findings were not mentioned in over 97% of case documents. Gonioscopy is not only an integral part of comprehensive ocular examination, but also an important one in elucidating mechanism of elevated-IOP. Unfortunately, it is a neglected tool in clinical ophthalmology practice.^[14,16] In this retrospective analysis, elevated-IOP was more prevalent with angle closure than primary open angle. The proportion of open and close angle varies with ethnicity and population composition. Every elevated-IOP should be actively looked for angle closure as underlying mechanism, especially in patients of Asian ethnicity. The proportion of angle closure glaucoma in south-east population is high compared to Caucasian population, necessitating gonioscopy to be an integral part of clinical ocular examination.^[1,17] In Chennai glaucoma study, as many as 40% cases of PACG patients were being treated as POAG.^[10] This probably results from lack of incorporating gonioscopy as part of clinical workup. We noted that only 2.5% referral sheets had gonioscopy findings. The importance of gonioscopy need not be emphasized in eyes with elevated-IOP, as initial management of OHT and PAC is different.^[2] Gonioscopy got precedence over pachymetry in algorithmic approach applied for evaluation of elevated-IOP in this study [Fig. 2]. The higher CCT in setting of angle closure may falsely assure clinician in favor of *probable-OHT* and gonioscopy may be skipped. Nearly 14% patients of PAC had CCT > 550 μm . In PAC patients post-YAG PI also, a higher CCT should not falsely assure clinician, as trabecular meshwork may be damaged at tissue level and function sub-normally despite angles being open on gonioscopy.^[18] Though the relationship between CCT and progression of PAC to PACG is not well studied, thinner CCT (<540 μm) has been associated with visual field progression in PACG patients.^[19,20]

We found a number of patients with elevated-IOP being started on IOP-lowering topical drops. This notion equates elevated-IOP with OHT. However, the benchmark glaucoma trials on OHT defines it on the basis of IOP and angle status on gonioscopy.^[21,22] Further, these trials reiterated that thick corneas are protective against progression to glaucoma in patients of OHT.^[23,24] This can also be interpreted as IOPs are recorded "falsely high" with GAT in patients with thick CCT. There is no consensus algorithm to know CCT adjusted IOP.^[25] The relationship between glaucomatous conditions and CCT is not linear. OHT overdiagnosis has been reported in as many as 40% cases, if CCT is not considered when interpreting measured IOP.^[8,26] In our study, 17% of the patients had over-estimation of IOP on GAT due to higher CCT. The likelihood of progression in eyes with thick cornea is low in some cases, whereas in others it is independent of CCT.^[27] Therefore, in clinical practice use of distinct term, stratifying the risk of progression may be desirable. Whether these patients should be treated or observed depends on presence of other risk factors. We used the term "Probable OHT" for the eyes

with elevated-IOP (GAT >22 mmHg) and thick CCT (>550 μm). We are of the opinion that supplementary tagging of diagnosis of "OHT" or "Probable OHT", such as "OHT-with risk factors" or "Probable OHT-with risk factor" might be helpful in highlighting multiplied risk of progression to glaucoma. Similarly, in PACS patients IOP is recorded elevated if CCT is high, and patient may be erroneously labelled as PAC. These patients could be labelled as "Probable PAC" to differentiate them from true PAC cases. Though it might be a difficult call to differentiate between true and probable PAC, and decision for prophylactic PI may require additional considerations.

Careful comprehensive examination not only guides in grouping the glaucomatous conditions in open angle and angle closure type, but also helps to categorize them as primary and secondary. A detailed clinical history and careful slit-lamp examination is essential in all patients with OHT. The proportion of secondary glaucomatous conditions is small but significant.^[28] Therapeutic importance of early recognition of secondary glaucomatous conditions, including secondary OHT among patients of elevated-IOP need not be overemphasized.

Conclusion

In conclusion, in this study we found that a comprehensive clinical examination based on recommended standards is lacking in clinical practice, promoting erroneous diagnosis of glaucoma-related conditions. Elucidating the underlying mechanism for elevated-IOP in an individual case may guide in deciding correct treatment for lowering the IOP.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- Feder RS, Olsen TW, Prum BE Jr, Summers CG, Olson RJ, Williams RD, *et al.* Comprehensive adult medical eye evaluation preferred practice pattern® guidelines. *Ophthalmology* 2016;123:P209-36.
- Weinreb RN, Aung T, Medeiros FA. The pathophysiology and treatment of glaucoma: A review. *JAMA* 2014;311:1901-11.
- Colton T, Ederer F. The distribution of intraocular pressures in the general population. *Surv Ophthalmol* 1980;25:123-9.
- Hollows FC, Graham PA. Intra-ocular pressure, glaucoma, and glaucoma suspects in a defined population. *Br J Ophthalmol* 1966;50:570-86.
- Wong EY, Keeffe JE, Rait JL, Vu HT, Le A, McCarty C, *et al.* Detection of undiagnosed glaucoma by eye health professionals. *Ophthalmology* 2004;111:1508-14.
- Quigley HA, Jampel HD. How are glaucoma patients identified? *J Glaucoma* 2003;12:451-6.
- Foster PJ, Buhmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. *Br J Ophthalmol* 2002;86:238-42.
- Thomas R, Korah S, Muliylil J. The role of central corneal thickness in the diagnosis of glaucoma. *Indian J Ophthalmol* 2000;48:107-11.
- Vaahoranta-Lehtonen H, Tuulonen A, Aronen P, Sintonen H, Suoranta L, Kovanen N, *et al.* Cost effectiveness and cost utility of an organized screening programme for glaucoma. *Acta Ophthalmol Scand* 2007;85:508-18.

10. Vijaya L, George R, Baskaran M, Arvind H, Raju P, Ramesh SV, *et al.* Prevalence of primary open-angle glaucoma in an urban south Indian population and comparison with a rural population. The Chennai glaucoma study. *Ophthalmology* 2008;115:648-54.
11. Thomas R, Loibl K, Parikh R. Evaluation of a glaucoma patient. *Indian J Ophthalmol* 2011;59(Suppl S1):43-52
12. European glaucoma society terminology and guidelines for glaucoma, 4th edition-Part 1 supported by the EGS foundation. *Br J Ophthalmol* 2017;101:1-72.
13. Thomas R, Parikh RS. How to assess a patient a patient a patient for glaucoma. *Community Eye Health* 2006;19:36-7.
14. Choudhari NS, Pathak-Ray V, Kaushik S, Vyas P, Ronnie G. Prevalent practice patterns in glaucoma: Poll of Indian ophthalmologists at a national conference. *Indian J Ophthalmol* 2016;64:715-21.
15. Kouchaki B, Hashemi H, Yekta A, Khabazkhoob M. Comparison of current tonometry techniques in measurement of intraocular pressure. *J Curr Ophthalmol* 2016;29:92-7.
16. Ma S, Rana S, Tannir J, Hughes B, Shukairy A, Nagori S, *et al.* Frequency of gonioscopy and pachymetry on first visit glaucoma patients. *Invest Ophthalmol Vis Sci* 2014;55:5566.
17. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: A systematic review and meta-analysis. *Ophthalmology* 2014;121:2081-90.
18. Sihota R, Goyal A, Kaur J, Gupta V, Tapas CN. Scanning electron microscopy of the trabecular meshwork: Understanding the pathogenesis of primary angle closure glaucoma. *Indian J Ophthalmol* 2012;60:183-8.
19. Hong S, Kim CY, Seong GJ, Hong YJ. Central corneal thickness and visual field progression in patients with chronic primary angle-closure glaucoma with low intraocular pressure. *Am J Ophthalmol* 2007;143:362-3.
20. Tan HK, Ahmad Tajuddin LS, Lee MY, Ismail S, Wan-Hitam WH. A Study on the central corneal thickness of primary angle closure and primary angle closure glaucoma and its effect on visual field progression. *Asia Pac J Ophthalmol (Phila)* 2015;4:161-5.
21. Gordon MO, Kass MA, for the Ocular Hypertension Treatment Study Group. The ocular hypertension treatment study: Design and baseline description of the participants. *Arch Ophthalmol* 1999;117:573-83.
22. Miglior S, Zeyen T, Pfeiffer N, Cunha-Vaz J, Torri V, Adamsons I. European glaucoma study prevention (EGPS) group. The European glaucoma prevention study design and baseline description of the participants. *Ophthalmology* 2002;109:1612-21.
23. Kass MA, Heuer DK, Higginbotham EJ, Johnson CA, Keltner JL, Miller JP, *et al.* The ocular hypertension treatment study: A randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma. *Arch Ophthalmol* 2002;120:701-13.
24. Miglior S, Zeyen T, Pfeiffer N, Cunha-Vaz J, Torri V, Adamsons I. European glaucoma study prevention (EGPS) group. Results of the European glaucoma prevention study. *Ophthalmology* 2005;112:366-75.
25. Weinreb RN, Brandt JD, Garway-Heath DG, Medeiros FA, editors. World Glaucoma Association Consensus Series-4: Intraocular Pressure. The Netherlands: Kugler Publications; 2007.
26. Vass C, Hirn C, Sycha T, Findl O, Bauer P, Schmetterer L. Medical interventions for primary open angle glaucoma and ocular hypertension. *Cochrane Database Syst Rev* 2007;2007:CD003167. doi: 10.1002/14651858.CD003167.pub3.
27. Jonas JB, Stroux A, Velten I, Juenemann A, Martus P, Budde WM. Central corneal thickness correlated with glaucoma damage and rate of progression. *Invest Ophthalmol Vis Sci* 2005;46:1269-74.
28. Krishnadas R, Ramakrishnan R. Secondary glaucomas: The tasks ahead. *Community Eye Health* 2001;14:40-2.