Glaucoma Pattern Amongst the Elderly Chinese in Singapore

D H J Sim,*_M Med (Ophth), FRCS (Edin), FRCOphth (UK)_, L G Goh,**_MBBS, M Med (Int Med), MRCGP_, T Ho,***_MBBS, MSc (PH)_

Abstract

Glaucoma is a major blinding condition and is more prevalent amongst the elderly. A population study of 479 elderly Chinese aged 60 years and older, and residing in Singapore was carried out to determine the prevalence of glaucoma. The overall glaucoma prevalence was 4.8% with normal tension glaucoma (61%) and primary angle closure glaucoma (26%) being the most prevalent forms of glaucoma. All cases were silent in presentation with 97% of cases previously undiagnosed. With the greying population in Singapore, the issue of screening the elderly for glaucoma should be considered.

Introduction

Glaucoma is a major cause of world blindness in developing and developed nations. The WHO Global data on blindness show that over half of the blind due to glaucoma reside in Asia, the majority being Chinese.[1] In the United States, glaucoma is the second leading cause of existing as well as new cases of irreversible blindness.[2] Glaucoma affects approximately 2 million Americans and direct costs related to diagnosis, management and work loss amount to over US$1 billion annually.[3] Glaucoma also exacts a toll on the individual, family and society that extends beyond financial terms.

Numerous prevalence studies have shown that the prevalence of glaucoma increases with age. The Beaver Dam study[4] reported a five-fold increase in glaucoma prevalence from the 43 to 54 years age group to those 75 years and older. The Japanese Nationwide Glaucoma Survey[5] reported a six-fold increase in prevalence from the 30 to 49 years age group to those 70 years and older. Age is an established and important risk factor for glaucoma.

With the greying population in Singapore, the burden of glaucoma will increasingly impose a strain on society as well as the health care system. This is particularly so as the majority of glaucomas are chronic and require lifelong treatment and monitoring. The Senior Citizen Eye Study was undertaken to determine the prevalence of glaucoma and other eye disorders in the Singapore population aged 60 years and above.

Materials and Methods

The study was conducted by the Home Nursing Foundation with ophthalmologists from the Department of Ophthalmology, Tan Tock Seng Hospital between 1991 and 1994.

Study Population

This was a cross-sectional random sample survey of the elderly Chinese aged 60 years and older, and residing in Singapore. A sampling frame of 3000 names was obtained from the database of the Ministry of Home Affairs based on the 1990 population census. From this multiracial sampling frame, the Chinese population was selected as the study population as it comprised the overwhelming majority. Letters were sent to the elderly to invite them to attend the eye screening sessions at Hougang Senior Citizens Health Care Centre.

Screening Examinations

The eye screening examinations were conducted over two visits. On the first visit, the respondent was seen by a trained nurse or trained therapy aide. A questionnaire was filled detailing demographic information, and

  * *Consultant Ophthalmologist, Specialist Eyecare Clinic*
    Visiting Specialist, Singapore National Eye Centre
    Visiting Consultant, Tan Tock Seng Hospital
    Associate Staff (Consultant), National University Hospital
 ** *Associate Professor*
    Department of Community, Occupational and Family Medicine
    National University of Singapore
*** *Registrar*
    Home Nursing Foundation
Address for Reprints: Dr D H J Sim, Specialist Eyecare Clinic, 1 Kim Seng Promenade, #01-38A Great World City, Singapore 237994.

relevant medical and ophthalmic history. An initial eye examination was performed comprising the following:

a) Visual acuity with a Snellen chart at 6 m. Acuity was recorded unaided, with a pinhole and with the respondents own spectacle refraction.
b) Air-puff tonometry was performed with the Topcon air-puff tonometer CT-20. The average of three readings was recorded for each eye.
c) Humphrey automated perimetry (Humphrey Field Analyser I) using the central 80 point screening test with threshold-related strategy.
d) Autorefraction with the Topcon RM-A2000 autorefractor. The average refraction of at least 3 readings per eye was recorded.
e) Retinal fundus photography with the Topcon TRC-NW3 non-mydriatic camera with the image (45 degree field) captured on Polaroid film.

The second visit comprised a comprehensive eye examination by an ophthalmologist from the Department of Ophthalmology, Tan Tock Seng Hospital. The examination comprised the following:

a) Repeat autorefraction with the Topcon autorefractor.
b) Slit lamp examination.
c) Goldmann applanation tonometry.
d) Gonioscopy with a Goldmann 2 mirror contact lens. Angle findings were graded from 0 to 4 using Becker-Shaffer's classification.[6]
e) Fundus and disc examinations were done through a dilated pupil by indirect ophthalmoscopy with a 20 dioptre lens. This was supplemented when necessary with slit lamp examination with a 90 dioptre indirect lens or the Goldmann contact lenses. The optic discs were examined and cup-to-disc ratios were assessed.

All fundus photographs were reviewed and the cup-disc ratio of the optic nerve head in the vertical meridian was assessed. Only photographs with sufficient clarity of the optic nerve were included in this assessment. The initial cup-disc ratio assessments made on clinical examination by the examining ophthalmologists in these cases were revised if the results differed from the photographs. As non-stereoscopic fundus Polaroid photographs were used, cup pallor was used as a guide, but disc vessel kinking at the cup margin was the primary criterion for determining the cup margin.[7] All photographs of discs with cup-disc ratios equal or greater than 0.8 were assessed twice.

All Humphrey visual fields were reviewed and classified as glaucomatous, non-glaucomatous or indeterminable e.g. when there was coincident significant retinal pathology. A field was considered glaucomatous if there was a significant scotoma in an arcuate or nasal step pattern or in Bjerrum's area. A significant scotoma was defined as one consisting of at least 3 confluent test points. The most superior 4 test points and the most inferior 2 test points of the test pattern were not considered as defects as these points might be artifactual. If significant parapapillary chorioretinal degeneration was detected on the fundus photos, the ring of test points immediately adjacent to the blind spot was also excluded. As the threshold related strategy was used, any defect on the visual field would be at least 6 dB below threshold.

Diagnostic Classification

An angle was classified as occludable when at least 3 quadrants were graded Shaffer grade 1 or narrower.[8] Primary angle closure glaucoma (PACG) was diagnosed if the eye had occludable angles, a cup-disc ratio of 0.8 or greater and a glaucomatous visual field.

Primary open angle glaucoma (POAG) was diagnosed if the cup-to-disc ratio was 0.8 or greater with a glaucomatous visual field, non-occludable angles and an intraocular pressure greater than 21 mmHg. Normal tension glaucoma (NTG) was diagnosed if the criteria for POAG were fulfilled and the intraocular pressure was 21 mmHg or less. Ocular hypertension was diagnosed when the intraocular pressure (IOP) was greater than 21 mmHg in the absence of disc and field criteria for glaucoma. Only Goldmann applanation tonometry readings were used for diagnostic classification.

Results

From the sampling frame of 3000 names, 418 could not be contacted. Out of the remaining sampling frame of 2582 names, 2013 (78%) were Chinese. From this Chinese sampling frame, 1530 declined to participate and a further 4 individuals did not complete both eye exams leaving 479 respondents who completed both eye exams. This gives a response rate of 23.8%. A comparison of demographics of respondents to non-respondents revealed that respondents were generally younger with less representation in the 70 years and above age group.

The 479 respondents made up the study population. The age of the respondents ranged from 60 to 95 years, with a mean age of 69 years. Two hundred and thirty (48%) were males and 249 (52%) females. The age and sex distribution of the study population is shown in Table I.

Twenty-three cases of glaucoma were identified in the study population giving a prevalence of 4.8%. Of these, 14 (61%) were NTG, 3 (13%) POAG and 6 (26%) PACG. All cases had a typical chronic glaucoma presentation with no pain, ocular inflammation or any overt symptoms or signs. During the course of the study, 1 case of neovascular glaucoma was recognised and referred for further management. This patient, however, did not complete the study and is not reflected in the study statistics.

TABLE I: AGE AND SEX DISTRIBUTION OF THE STUDY POPULATION

Age (years)	Male	Female	Total
60 - 64	68	71	139
65 - 69	71	78	149
70 - 74	45	46	91
75 and over	46	54	100

Thirty-nine respondents with ocular hypertension were identified with 58 eyes with an IOP greater than 21 mmHg. The mean IOP of these eyes was 26 mmHg. Forty-two respondents or 8.8% of the study population had occludable angles. Six of these respondents were diagnosed with PACG.

Seven respondents in the study population had a previous diagnosis of glaucoma. Of these, 5 were diagnosed to have bilateral glaucoma. Six respondents had received glaucoma surgery and 1 was treated with topical eye-drops. None of these cases had an IOP greater than 21 mmHg. Only one case satisfied the study diagnostic criteria for glaucoma and this was the case on topical glaucoma medication with primary open angle glaucoma. The other 6 cases had previous glaucoma surgery. Of these 6, only 2 had a glaucomatous field defect.

Of the 23 cases of glaucoma, 96% were previously undiagnosed. If all previously diagnosed glaucomas were included, irrespective of whether they fulfilled the study criteria for glaucoma, the overall glaucoma prevalence figure would be 6%. Of this, 76% would have been previously undiagnosed.

The mean IOP of the study population was 15.6 mmHg with a mean standard deviation of 4.3 mmHg. The mean IOP plus 2 standard deviations was 24.2 mmHg. If all cases of glaucoma were excluded, the mean IOP plus 2

TABLE II: MEAN INTRAOCULAR PRESSURES IN THE STUDY POPULATION

IOP (mmHg)	Entire population	"Normal" population*
Mean IOP	15.6	15.5
SD	4.3	4.1
Mean + 2 SD	24.2	23.7

* Excluding subjects with glaucoma

TABLE III: MEAN IOP BY AGE AND SEX IN THE STUDY POPULATION

Age (years)	Mean intraocular pressure (mmHg)		
	Male	Female	Both
60 - 64	15.2	16.6	15.9
65 - 69	15.1	15.8	15.5
70 - 74	15.3	15.8	15.5
75 and over	15.1	15.5	15.3

standard deviations was 23.7 mmHg (Table II). The mean IOPs of females were generally higher than males. Table III summarises the mean IOPs by age and sex. A trend towards lower IOPs with increasing age was apparent. This is consistent with the studies in Japan[5] and Mongolia.[9]

The mean cup-disc ratio was 0.43 with a standard deviation of 0.21. If all cases of glaucoma were excluded from the study population, the mean cup-disc ratio was 0.42 with a standard deviation of 0.2.

Only 7 out of the 479 respondents gave a positive family history for glaucoma. Of these seven, 1 was diagnosed to have normal tension glaucoma. One hundred and eighty-six respondents had previously been seen by an ophthalmologist, and of these, 8 were newly diagnosed to have glaucoma in this study. Of these 8, 6 were diagnosed with normal tension glaucoma, 1 with POAG and another with PACG.

Discussion

POAG and PACG are the most prevalent forms of glaucoma. POAG is the predominant form of glaucoma in Caucasian populations. Normal tension glaucoma comprises a subset of POAG in which the intraocular pressures are not raised above the traditional limit of 21 mmHg. This arbitrary limit of 21 mmHg was arrived at statistically, by adding 2 standard deviations to the mean intraocular pressure for the Caucasian populations. This limit however, does not necessarily apply to other populations. In China[10] and Japan,[5] this limit is closer to 19 mmHg.

In our study, the limit for our Chinese elderly was 24 mmHg (Table II). As the IOP mean also tends to change with age (Table III), logically, different limits should be applied to different age groups. These figures were however based on population averages and are not entirely helpful when dealing with an individual. Due to normal variation, each individual will have his or her individual normal pressure. Individual pressure also fluctuates diurnally. Furthermore, other non-pressure dependent factors may be important in the aetiology of POAG.

The Chinese population is recognised to have a greater propensity to developing PACG.[9-12] This has been attributed to anatomical differences between Asian and Caucasian eyes.[13-15] Unlike POAG, PACG is characterised by anatomical angle closure, which can be quantified by gonioscopy. This angle closure is direct evidence of compromised aqueous outflow, which results in raised IOP. Raised IOP is therefore central to PACG, whether it is intermittently raised as in intermittent angle closure, or chronically raised as in advanced chronic angle closure glaucoma. IOP and gonioscopic findings are therefore important in the diagnosis of PACG. The differences between POAG and PACG have important bearing on

how glaucoma should be defined in a population study to estimate, as accurately as possible, the true prevalence of the different glaucomas. One should note that the definition for glaucoma in this study tends to be skewed towards diagnosing more advanced cases and may result in the underdiagnosis of the condition.

This might account for the fact that most of the respondents with a previous diagnosis of glaucoma did not fulfil the study criteria for a diagnosis of glaucoma. This however, might also point to a possible overdiagnosis of glaucoma based mainly on raised IOP[4] alone. This is important as many individuals have ocular hypertension with raised IOPs but do not have glaucoma and do not require treatment.

One of the main limitations of this study was the limited response rate of 23.8%. This is despite repeated attempts to encourage the elderly individuals to attend the screening exams. This is probably partly due to the fact that we were targeting an elderly population which is less mobile and more dependent on others to bring them for these screening exams. It is also probably a reflection of the attitude of our elderly towards health screening, especially when they are asymptomatic. The study population was therefore open to selection bias. One should note however that of the 23 cases of glaucoma detected, 22 were previously undiagnosed. Of the 22 new cases, no overt symptoms were experienced although half did experience non-specific blurring of vision.

The glaucoma prevalence of 4.8% in our Chinese population (60 years and older) is comparable with those in many other populations. In the Japanese Nationwide Survey,[5] the prevalence for the population (70 years and older) was 6.1%. In the Mongolian study,[9] the prevalence for the population (60 years and older) was 6.3%. Table IV summarises a comparison of glaucoma prevalence rates between elderly Singaporean Chinese, Japanese and Mongolians. The Beaver Dam study in the United States focused on a mainly Caucasian population and reported a prevalence of 3.5% in the population aged 65 years and older. The Baltimore study in the United States reported a prevalence of 6.5% in the Black population[13] aged 60 years and older.

TABLE IV: GLAUCOMA PREVALENCE AMONGST THE ELDERLY
IN ASIA

	Singapore	Japan[5]	Mongolia[8]
Age (years)	60 and older	70 and older	60 and older
Overall prevalence (%)	4.8	6.1*	6.3*
NTG prevalence (%)	2.9	4.0*	1.3*
POAG prevalence (%)	0.6	1.3*	0.8*
PACG prevalence (%)	1.3	0.8*	3.8*

* Calculated from published data

The high prevalence of PACG in our Chinese study population is consistent with epidemiological data from China[10] and Mongolia.[9] The high prevalence of normal tension glaucoma amongst our Chinese elderly has however, not been recognised. This high prevalence is however not entirely surprising, given the high prevalence of normal tension glaucoma amongst the elderly in Japan[5] (Table IV) and the West.[13] Clinic-based prevalence figures for glaucoma in Singapore suggest a predominance of PACG as opposed to POAG in the ratio of 4:1 (Loh 1968)[11] and 2.8:1 (Lim 1978).[12] However, as these figures were clinic-based, they are naturally more skewed in favour of PACG, which tends to be more symptomatic and have raised IOPs.

In our study, 96% of glaucomas were previously undiagnosed. This compares with 80% in Japan[5] and 90% in the Beaver Dam study.[4] This is highly significant and is one of the probable reasons for the high prevalence of glaucoma blindness in the world. The main reason for these large numbers of undiagnosed cases is that chronic glaucomas are essentially asymptomatic, the symptoms typically being evident only in the advanced stages of the condition. Even with advanced damage and overt visual disturbance, many elderly attribute this to more benign conditions such as cataract or the need for glasses with ageing. It is therefore not unusual for patients to present late with irreversible blindness.

The rate of damage from glaucoma accelerates with advancement of the condition. It thus becomes increasingly more difficult to prevent further damage the more advanced the glaucoma is at presentation. Early detection and treatment[16] can retard or halt further progression. The apparent answer to curb blindness from glaucoma is to screen the population to enable earlier detection. Screening the general population for glaucoma is however generally not widely practiced because no cost-effective screening programme has been developed. This is due to the complexities of glaucoma diagnosis and the current cost of screening. There is however a case for screening high-risk populations such as the elderly. Furthermore, technology is continually bringing forth new methods for screening and diagnosing glaucoma, which may prove more practical and cost-effective in the future.

REFERENCES

1. Thylefors B, Negrel A D, Parajasegaram R, Dadzie K Y. Global data on blindness. Bull World Health Organisation 1995; 73(Pt1):115-21.

2. Leske M C. The epidemiology of open-angle glaucoma: A review. Am J Epidemiol 1983; 118:166-91.

3. Tucker J B. Screening for open-angle glaucoma. Am Fam Physician 1993; 48(Pt1):75-80.

4. Klein B E K, Klein R, Sponsel W E, Franke T, Cantor L B, Martone J, et al. Prevalence of glaucoma, The Beaver Dam Eye Study. Ophthalmology 1992; 99(Pt10):1499-504.

5. Shios Y, Kitazawa Y, Tsukahara S, Akamatsu T, Mizokami K, Futa R, et al. Epidemiology of glaucoma in Japan—A nationwide glaucoma survey. Jpn J Ophthalmol 1991; 35:133-55.

6. Kolker A E, Hetherington J. Clinical interpretation of gonioscopic findings. In: Becker-Shaffer, editor. Diagnosis and Therapy of the Glaucomas. 3rd ed. St Louis: Mosby, 1970:41-50.

7. Schwartz B. Cupping and pallor of the optic disc. Arch Ophthalmol 1973; 89:278-86.

8. Arkell S M, Lightman D A, Sommer A, Tyler H R, Korshim O M, Tielsch J M. The prevalence of glaucoma among Eskimos of Northwest Alaska. Arch Ophthalmol 1987; 105:482-5.

9. Foster P J, Baasanhu J, Alsbirk P H, Munkhbayar D, Uranchimeg D, Johnson G J. Glaucoma in Mongolia: A population-based survey in Hovsgol Province, Northern Mongolia. Arch Ophthalmol 1996; 114:1235-41.

10. Hu C N. An epidemiological study of glaucoma in Beijing and Shunyi county. Chin J Ophthalmol (Chinese) 1989; 25:115-9

11. Loh R C K. The problems of glaucoma in Singapore. Singapore Med J 1968; 9:76-80.

12. Lim A S M. Primary angle-closure glaucoma in Singapore. Aust J Ophthalmol 1979; 7:23-30.

13. Tielsch J M, Sommer A, Katz J, Royall R M, Quigley H A, Javitt J. Racial variations in the prevalence of primary open-angle glaucoma. JAMA 1991; 266(Pt3):369-74.

14. Lowe R F. Aetiology of the anatomical basis for primary angle-closure glaucoma. Br J Ophthalmol 1970; 54:161-9.

15. Lowe R F. Primary angle-closure glaucoma: A review of ocular biometry. Aust J Ophthalmol 1977; 5:9-17.

16. Jay J, Allen D. The benefit of early trabeculectomy versus conventional management in primary open angle glaucoma relative to severity of disease. Eye 1989; 3:528-35.