DIURNAL INTRAOCULAR PRESSURE VARIATION IN LOW-TENSION GLAUCOMA

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SUMMARY

A retrospective analysis of diurnal variation in intraocular pressure (IOP) in 101 untreated low-tension glaucoma (LTG) patients was carried out to ascertain the role of IOP as a causative factor in the aetiology of optic nerve damage in LTG. The diagnosis of LTG was made only after IOP monitoring as an inpatient, which involved 2 hourly consecutive measurements by Goldmann applanation tonometry from 08:00 to 22:00 hours inclusive. The highest IOP during the diurnal curve was 17.4 mmHg (SD 3.00) at 10:00 and the lowest value was 15.0 mmHg (SD 2.7) at 22:00. Seventy-seven per cent of patients had a peak IOP value recorded between 08:00 and 12:00 hours inclusive. The mean peak IOP was 18.3 mmHg (SD 2.6) and the mean trough was 13.1 mmHg (SD 2.2). Thus the mean diurnal range in IOP of 5.2 mmHg (SD 2.2) was similar to that reported by other workers in normals. Neither the diurnal pattern nor the range of IOP values seen in this study supports the view that abnormal IOP levels are a significant risk factor in the pathogenesis of optic nerve damage in all patients with LTG.

Diurnal variation in intraocular pressure (IOP) was initially described in 1898 by Sidler-Huguenin.[1] Fifty years later Duke-Elder, using a Schiotz tonometer, confirmed that this variation rarely exceeded 5 mmHg in the normal population.[2] As IOP is a dynamic event, continuous monitoring is essential not only to determine the pattern of IOP distribution within the individual, but also to differentiate patients with high-pressure glaucoma from those with low-pressure glaucoma. Patients with primary open angle glaucoma (POAG) demonstrate greater lability in their IOP during the day[3–6] and IOP is known to be both a cause and a magnitude-related risk factor in POAG.[7,8] Its role in the pathogenesis of low-tension glaucoma (LTG) is still unclear. We therefore analysed the diurnal distribution and behaviour of IOP in 101 LTG patients, in an attempt to explore the role of IOP in LTG.

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SUBJECTS AND METHODS

The patients were identified from a retrospective review of 235 case notes of patients seen in the LTG clinic at Moorfields Eye Hospital between January 1981 and June 1992. All 101 patients in the study fulfilled the selection criteria in Table I. One eye of each patient was randomly selected for inclusion in the study. Sixty-two women and 39 men were analysed with a mean age of 62.4 years (SD 10.4, range 38–86 years). Ninety-three patients were Caucasian and the remaining 8 were black. Nine patients had a medical history of systolic hypertension (none of whom were receiving systemic beta blockers) and 2 were diabetic.

Patients were admitted overnight to the hospital for inpatient monitoring of IOP. The first IOP was recorded at 10:00 and thereafter at 2 hourly intervals until 22:00 hours, and finally at 08:00 the next morning. Only those patients who had all eight recordings of IOP during inpatient admission were analysed in this study. IOP was measured by residents or glaucoma technicians using Goldmann applanation tonometry and slit lamp biomicroscopy.

RESULTS

The diurnal variation in IOP is shown in Table II and Fig. 1. The highest IOP of 17.4 mmHg (SD 3.0) occurred

Table I. Patient selection criteria

1. Intraocular pressure less than 22 mmHg at all clinic visits (patients were, however, allowed to have one IOP reading greater than 21 mmHg but less than 24 mmHg during inpatient phasing)
2. Evidence of glaucomatous cupping and pallor of the optic disc
3. Characteristic and reproducible visual field defects (arcuate, paracentral and nasal scotomas or any combination thereof, with the Humphrey (static). Goldmann (kinetic) or Friedmann (static) perimeter)
4. Corrected visual acuity of 6/18 or better
5. An open angle confirmed by gonioscopy
6. Patients not using systemic or topical beta blockers or corticosteroids
7. Patients not using pressure-lowering therapy
8. No previous laser or filtration surgery
9. No evidence of intracranial pathology on neurological examination

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Table II. Diurnal variation in intraocular pressure (IOP, mmHg) in 101 low-tension glaucoma patients

Time	Mean IOP	(SD)
08:00	16.9	2.9
10:00	17.4	3.0
12:00	16.5	2.8
14:00	16.1	2.5
16:00	15.7	2.7
18:00	16.0	2.5
20:00	15.1	2.5
22:00	15.0	2.7

at 10:00 and gradually decreased during the day to reach its lowest value of 15.0 mmHg (SD 2.7) at 22:00 hours. The mean peak recording of IOP was 18.3 (SD 2.6) mmHg and the mean trough IOP was 13.1 mmHg (SD 2.2), giving a mean range of 5.2 mmHg (SD 2.2). The overall average recording for all measurements for all patients was 16.1 mmHg (SD 2.6).

Seventy-seven per cent of patients had their peak IOP recorded between 08:00 and 12:00 hours, with 42% having the peak at 10:00. Sixty-five per cent of patients had their lowest IOP recorded between 18:00 and 22:00 hours, with 31% of the lowest values occurring at 22:00.

DISCUSSION

The pathogenesis of optic nerve damage in LTG is not known, although both IOP and vascular risk factors have been postulated. Three recent studies demonstrate that in a sizable proportion of LTG patients with bilateral disease, the eye with the higher mean IOP tended to have greater optic nerve damage and visual field loss.[9–11] Systemic diseases such as arterial hypertension and diabetes mellitus have been associated with LTG, and recently considerable attention has been given to the possible contributory role of vasospastic disorders such as migraine and Raynaud's phenomenon in LTG.[12–14]

The purpose of this study was to determine whether the pattern and distribution of IOP in LTG contributed to the pathogenesis of neural damage in this disease. Our results are comparable with similar IOP studies in normals where the mean IOP diurnal variation measured by Goldmann applanation tonometry in a study by Kitazawa and Horie[5] was 6.4 mmHg (SD 1.3). Our results for the mean diurnal IOP range in patients with LTG – 5.2 mmHg (SD 2.2) – almost match that found in normals by David *et al.*[6] of 5.0 mmHg (SD 2.7). Thus the diurnal behaviour of IOP in LTG is unlikely to play a prominent role in the aetiology of optic nerve disease in all patients with LTG.

There are very few published data on diurnal IOP in low-tension (or normal-tension) glaucoma. Two recent Japanese studies give a mean diurnal IOP range of 5.5 mmHg (SD 1.6) and 4.8 mmHg (SD 1.8) respectively in LTG.[15,16] While these values are very similar to our results, the peak and trough IOP in these two reports – 16.5 mmHg and 11.2 mmHg[15] and 16.5 mmHg and 11.8 mmHg[16] respectively – are considerably different from our results of 18.3 mmHg and 13.1 mmHg respectively. It is therefore difficult to compare the results

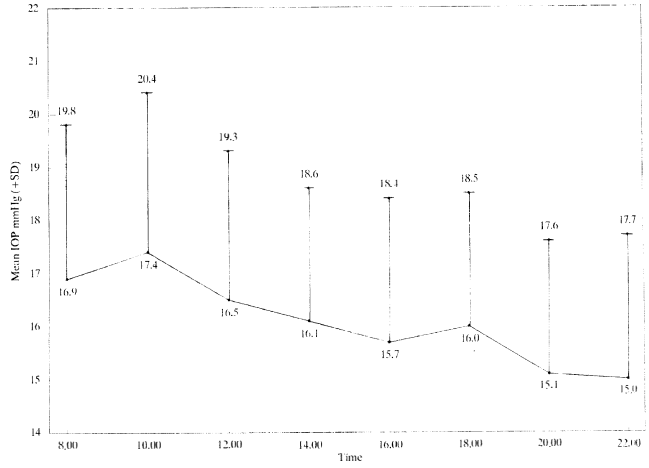

Fig. 1. *Diurnal variation in intraocular pressure in low-tension glaucoma.*

of the different studies directly. These differences may have arisen because of the different populations studied (Japanese as against mainly Caucasians).

Wilensky[17] has recently reported that all normals, 78% of ocular hypertensives and 72% of glaucoma patients have a diurnal rhythm in IOP curves with a peak pressure recorded either early morning (04:00 to 08:00) or late morning/early afternoon, the majority being late morning. Our data show that for the majority (77%) of LTG patients, the peak pressure is likely to occur in the morning period between 08:00 and 12:00 hours. This finding confirms recent observations in LTG.[15,16] The implication is that a single morning measurement will match the diurnal peak in three-quarters of the LTG population: so where facilities are limited, such assessment may substitute for a more comprehensive diurnal IOP evaluation. Diurnal IOP assessment (as described here) will, however, miss peak pressures which may occur between 22:00 and 8:00 hours. Diurnal pressure checks may still be needed as Ido *et al.*[15] found that 9 of 100 patients suspected of having LTG and therefore admitted for inpatient IOP monitoring had a peak pressure of more than 21 mmHg, causing them to be reclassified as POAG.

We were unable to demonstrate any significant variation in IOP from normal in our study of LTG patients. Yamazaki *et al.*[18] have recently shown that LTG patients with a maximum IOP greater than or equal to 19 mmHg had a significantly greater diffuse retinal nerve fibre layer loss than LTG patients with a maximum IOP of less than 19 mmHg. Thus further study is required to determine whether different diurnal patterns in IOP are associated with different patterns of optic damage and visual field loss in LTG.

Key words: Diurnal variation, Intraocular pressure, Low tension glaucoma.

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