

# Diurnal changes of the intraocular pressure of patients with angle-closure glaucoma

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**SUMMARY** The diurnal curves of 21 patients (40 eyes) with angle-closure glaucoma and of 21 normotensive subjects (42 eyes) were studied. The patients with angle-closure glaucoma had a V-shaped diurnal curve that was completely different from the diurnal curve of the normotensive subjects. Most of the eyes of the patients with angle-closure glaucoma had a diurnal change of the intraocular pressure of 8 mmHg or more, while in the normotensive subjects only 1 eye had a diurnal change as large as 8 mmHg.

The average normal intraocular pressure (IOP) of healthy eyes has been extensively studied. Measurements taken with the Schiøtz tonometer yielded an average IOP of 15.5 mmHg (Leydhecker *et al.*, 1958) to 17.0 mmHg (Weekers *et al.*, 1955) and with a Goldmann applanation an average of 14.5 mmHg (Draeger, 1959) to 15.6 mmHg (Levene, 1961). In the normal eye the IOP shows diurnal variations. The amplitude of the diurnal variations has been found to be 3 to 7 mmHg (Dobree, 1953; Alimuddin, 1956; Ericson, 1958; Katavisto, 1964; Duke-Elder and Jay, 1969), but in less than 1% of cases it was found to be as large as 10 mmHg (Drance, 1960). In about 40% of normal persons the IOP is somewhat higher in the early morning, while in about 60% it may reach its peak at random times during the day (Alimuddin, 1956; Drance, 1960; Katavisto, 1964; Daubs, 1973).

There is no available study of the diurnal curve of patients known or suspected to be suffering from angle-closure glaucoma (ACG). The present study deals with the diurnal curve of 21 patients (40 eyes) suffering from ACG and the diurnal curve of 11 (20 eyes) of these 21 patients 3 months after peripheral iridectomy.

## Patients and methods

Twenty-one patients (40 eyes) aged between 38 and 65 years were referred to Hadassah University Hospital Eye Department with the diagnosis of angle-closure glaucoma. Subjective complaints were ocular pain in 16 patients, blurred vision in 7 patients, light haloes in 4 patients. The diagnosis of

ACG was confirmed by the presence of some or all of the following findings: narrow angle gonioscopically during a normotensive period, a positive dark room test, and the closure of the angle while the IOP was raised.

Each patient was admitted to hospital and his IOP was measured 7 times a day at 3-hour intervals between 0600 h and midnight with the Goldmann applanation tonometer. The pressure measurements were carried out during 2 successive days.

After the diagnosis of ACG was confirmed a peripheral iridectomy operation was recommended to all patients, but only 11 (20 eyes) out of 21 patients agreed to be operated upon. Three months after the operation these 11 patients underwent repeated diurnal curve examinations as described above.

A control group of 21 normotensive persons (42 eyes) with normal looking angles, aged between 39 and 65 years, underwent the same diurnal curve examinations. They were admitted to hospital in the Eye Department because of ptosis (4 cases), dacryostenosis (11 cases), and immature cataract (6 patients). None of the patients or members of the normotensive control group, had either anterior or posterior synechiae or any other ocular lesions that would to our knowledge have a definite influence on the IOP.

All topical and systemic medications were stopped at least 48 hours before the examinations. IOP measurements were evaluated by the Mann-Whitney U test when appropriate.

## Results

The mean and standard deviation of the IOP during each of the time points in the diurnal curve of the

Table 1 Mean and standard deviation of IOP in mmHg of the patients with ACG, the patients who had peripheral iridectomy, and the normotensive control group

		Hours of measurement of IOP							
		0600 h	0900 h	1200 h	1500 h	1800 h	2100 h	2400 h	
Patients with ACG	Mean	18.56	18.22	17.39	16.87	17.27	17.71	18.77	
	SD	7.00	7.87	7.74	5.55	7.29	10.41	10.91	
Patients who had peripheral iridectomy procedure	Before the operation	Mean	17.46	17.89	16.27	17.05	18.03	18.43	19.05
		SD	4.85	6.54	4.19	5.31	7.42	11.66	12.94
	After the operation	Mean	15.58	14.11	14.03	13.95	14.50	14.08	14.53
		SD	4.23	4.14	3.11	2.77	3.78	3.28	3.36
Normotensive control group	Mean	14.44	14.21	13.64	14.31	13.95	13.51	13.57	
	SD	3.22	2.35	3.10	3.13	3.01	2.88	3.07	

patients with ACG, the patients who underwent peripheral iridectomy, and the normotensive control group are given in Table 1 and Fig 1. It is seen that the patients with ACG had a higher IOP average than the normotensive control group. The highest IOP in the patients with ACG was at midnight, and at 0600 h the IOP was only slightly lower than that at midnight. The lowest IOP was at 1500 h. The curve had a V-shape with a statistically significant difference between the pressures at 0600 h and midnight and the pressure at 1500 h ( $P < 0.01$ ). In the normotensive control group the highest IOP was at 0600 h with a statistically insignificant change during the day ( $P > 0.05$ ). A statistical analysis

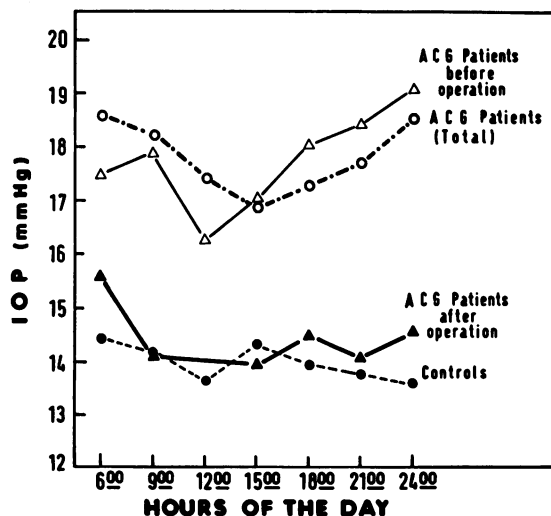


Fig. 1 Diurnal curve of IOP of the patients with ACG, the patients with ACG who had peripheral iridectomy before and after the operation, and the normotensive control group

proved that the diurnal curve of the patients with ACG was completely different from the diurnal curve of the normotensive control group ( $P < 0.01$ ). The patients who underwent a peripheral iridectomy showed a diurnal curve that was statistically similar to that of the normotensive control group ( $P < 0.05$ ).

The diurnal changes in the patients with ACG, the patients after undergoing peripheral iridectomy, and the normotensive control group are given in Fig. 2. A diurnal change of 8 mmHg was noted in the control group in 1 eye, and only in 1 of the 2 diurnal curve examinations performed on that eye. In the patients with ACG a diurnal change of 8 mmHg or more, at least in 1 of the 2 diurnal curve examinations, was noted in 26 (65%) eyes. In the patients who underwent peripheral iridectomy the diurnal changes in IOP were not as great as before the operation, but still 8 eyes (40%) had in 1 of the 2 diurnal curve examinations a change of 8 mmHg or more. The largest diurnal variation in the patients with peripheral iridectomy was 12 mmHg.

In each of the diurnal curve examinations the lowest IOP measurements of the patients with ACG ranged between 7 and 25 mmHg, with mean of 13.7 mmHg and a median of 20.0 mmHg. The lowest IOP measurements of the normotensive control group ranged between 7 and 16 mmHg, with a mean of 11.5 mmHg and a median of 12.0 mmHg.

## Discussion

The present study includes a comparison of the diurnal curve and the diurnal change of patients with ACG and a normotensive control group. The difference between the diurnal curves is highly significant ( $P < 0.01$ ). In the patients with ACG the

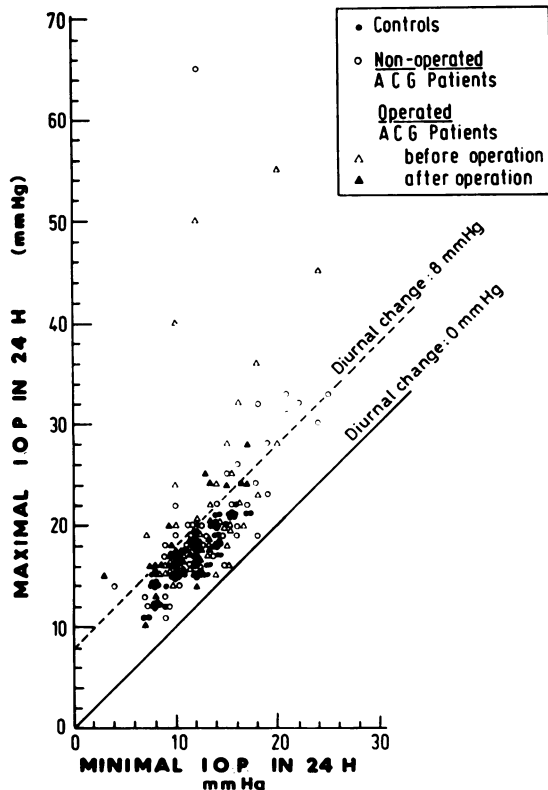


Fig. 2 Maximal and minimal diurnal IOP of the patients with ACG who were not operated on, the patients with ACG who had peripheral iridectomy before and after the operation, and the normotensive control group

average IOP is higher than that of the normotensive control group at any time point in the diurnal curve. In the patients with ACG high tensions are at 0600 h and midnight, and a comparatively low tension is at 1500 h, giving to the diurnal curve a V-shape. The diurnal curve in the normotensive control group has no significant fluctuations. Dilatation of the pupil in darkness with subsequent disturbance to the aqueous drainage can explain the V-shape of ACG patients' diurnal curve. Patients after peripheral iridectomy have a diurnal curve that is more like that of the control group, and that is due to the abolition of the possibility of a pupillary block.

In other studies (Dobree, 1953; Alimuddin, 1956; Ericson, 1958; Katavisto, 1964), as well as in our control group, the IOP variations of the normal people rarely exceeded 8 mmHg. Therefore we adopted Drance's definition that a diurnal variation of 8 mmHg or more is abnormal (Drance, 1960). A

change of 8 mmHg or more was noted at least in 1 of the 2 days' diurnal curves in 65% of the eyes of the patients with ACG, while in the normotensive control group there was a change of 8 mmHg in 2% of the eyes, and the rest had a lower diurnal change. We have no explanation of the finding that in 40% of the eyes of the patients after peripheral iridectomy there was still a change of 8 to 12 mmHg, at least in 1 of the 2 days' diurnal curves. That change was in spite of the fact that none of the patients had plateau iris.

It is worth noting that most of the patients with ACG have IOP measurements during some hours of the day which are almost as low as those of the normotensive control group. These patients are usually given a provocative test to detect increase of IOP. It seems to us that provocative tests are influenced by the pressure at the beginning of the test and by the trend of the diurnal curve. A patient suspected of having ACG may on one occasion have a positive result and on another a negative result merely because the examinations are started at 2 different points of the diurnal IOP curve. We intend to investigate that carefully.

The present study shows that a diurnal curve with a V-shape and a difference of 8 mmHg or more during 24 hours can be a valuable test confirming the diagnosis of ACG. Its results are not subject to artifacts as those of the provocative tests may be.

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