Intraocular pressure and pupillary responses in patients with diabetes mellitus

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Summary: Intraocular pressure (IOP) and the mydriatic responses to darkness in 38 diabetic patients have been compared with those of a matched control group of normal subjects. Overall, the diabetic patients had a significantly higher mean IOP than the control group, but this difference was not found in a sub-group of 13 diabetic patients with evidence of autonomic neuropathy. Those diabetic patients with evidence of autonomic neuropathy had a smaller mydriatic response to darkness than the control group, and this test may usefully be added to standard tests of autonomic function in the diagnosis of autonomic neuropathy.

Introduction

There appears to be a relationship between diabetes and raised intraocular pressure (IOP). It has been reported that abnormal oral glucose tolerance tests and evidence of autonomic neuropathy are more prevalent in patients with ocular hypertension and glaucoma than in the normal population.^{1,2} The authors suggested that glaucoma may be a physical sign of diabetes mellitus, although another study³ could find no difference in the glucose tolerance of patients with closed-angle glaucoma compared with normal subjects. It is also well documented that glaucoma is more prevalent in diabetic patients than in normal control groups.^{4,5} Autonomic neuropathy is a specific complication of diabetes mellitus,⁶ and the pupils of diabetic patients with autonomic neuropathy dilate less in darkness than those of normal controls.⁷

We have compared IOP and the mydriatic response to darkness in a group of diabetic patients with those of a matched control group of normal subjects.

Methods

Thirty eight patients (29 males) from the diabetic clinic of this hospital, already diagnosed as having type I or type II diabetes mellitus, volunteered for the study and were screened for evidence of autonomic neuropathy with the criteria that one or more of the following tests were positive.⁸

1. Heart rate variation during deep breathing, calculated from a continuous electrocardiogram (ECG) tracing recorded during 6 successive deep breaths.
2. Immediate heart rate response to standing using a continuous ECG tracing.
3. Blood pressure response to standing, using the Dinamap vital signs monitor, 1846.
4. Blood pressure response to sustained hand grip, using a sphygmomanometer with its cuff replaced by an inflatable bag as a handgrip dynamometer.

IOP was measured by non-contact tonometry,^{9,10} which has a mean intra-individual within-time between days coefficient of variation of 9.5%.¹¹ Pupillary responses to darkness, expressed as the ratio of pupil:iris diameter (%) after 1 minute in total darkness, were measured by photography using a Polaroid CU-5 Close-Up hand camera with a built-in flash, 1:3 ratio multiplier and frame. Preliminary studies had shown that the mean intra-individual within-time between days coefficient of variation of the method was 4.5%.¹¹

IOP measurements and pupil:iris diameter ratios (P/I%) of the diabetic subjects were compared with those of 38 normal subjects matched for age, sex and eye colour, using Student's unpaired *t*-test. The study was approved by the local ethics committee, and all subjects gave their consent to participate.

Results

Mean ($\pm$ s.d.) values of age, IOP measurement and P/I% ratios are shown in Tables I and II. The mean IOP values of the diabetic patients were

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Accepted: 29 October 1990

Table I Mean ($\pm$ s.d.) age, IOP and pupil/iris ratio (%) of 38 diabetic patients, and normal controls matched for age, sex and eye colour

	<i>n</i>	<i>Age (y)</i>	<i>IOP mmHg</i>		<i>P/I%</i>
			<i>Right</i>	<i>Left</i>	
Diabetic patients	38	40 (15)	15.3* (3.4)	15.3* (3.3)	52.26 (9.24)
Normal controls	38	41 (14)	13.3 (4.3)	13.2 (4.6)	55.78 (9.03)

**P* < 0.05 compared with controls.

Table II Mean ($\pm$ s.d.) age, IOP and pupil/iris ratio (%) of 13 diabetic patients with autonomic neuropathy and their normal controls matched for age, sex and eye colour

	<i>n</i>	<i>Age (y)</i>	<i>IOP mmHg</i>		<i>P/I%</i>
			<i>Right</i>	<i>Left</i>	
Diabetic patients with autonomic neuropathy	13	49 (13)	15.4 (3.8)	15.6 (4.0)	45.05* (8.46)
Normal controls	13	49 (13)	15.5 (4.5)	15.2 (5.0)	52.75 (9.69)

**P* < 0.05 compared with controls.

significantly higher than those of their matched controls (*P* < 0.05) in both right and left eyes. The IOP values of the patients with evidence of autonomic neuropathy (13 patients, 9 males) were not significantly different from those of their matched controls. The mean P/I ratio of the diabetic patients was not significantly different from the controls overall, but the mean ratio of the 13 patients with evidence of autonomic neuropathy

was significantly lower (*P* < 0.05) than that of their matched controls.

Discussion

These results show that diabetic patients with no previous history of ocular hypertension had a significantly higher mean IOP than a normal control group matched for age, sex and eye colour. This difference was not found, however, in a sub-group of patients with evidence of autonomic neuropathy. These findings run contrary to the conclusion of other investigators that ocular hypertension is more prevalent in diabetics with, rather than without, evidence of autonomic neuropathy.^{1,2} and this question, therefore, requires further investigation in larger numbers of subjects. However, since the prevalence of glaucoma is increased in diabetic patients,^{4,5} our observations of increased IOP in a group of patients taken from a diabetic clinic, would suggest that the IOP of diabetic patients should be measured routinely at regular intervals to detect the development of ocular hypertension at an early stage. The non-contact tonometer provides a convenient method for such a screening procedure, as it requires no topical anaesthesia or contact with the eye, and is quickly carried out.

Our results also confirm the observations of other investigators⁷ that diabetic patients with other evidence of autonomic neuropathy have a smaller mydriatic reaction to darkness than a control group. This test may usefully be added to standard tests of autonomic function in the diagnosis of autonomic neuropathy. It is possible that the normal IOP in these patients is associated with their reduced P/I ratio, and the increased aqueous drainage accompanying it.

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