A PHYSICIAN'S ASSESSMENT OF 300 PATIENTS IN A GLAUCOMA CLINIC*†

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THE aetiology of glaucoma has remained something of a mystery since the condition was first effectively described in the 17th century by Bannister (Singer and Underwood, 1962). Much work has been done on the purely ophthalmological side but the influence of general systemic states or diseases has not received much attention. Generalizations appear in all treatises on glaucoma, but few precise studies have been made of glaucomatous patients as a whole, and this paper sets out to help to remedy that defect. Three hundred patients have been studied personally by the author. The subject has required persistent interest over many years and while the content of this paper may be criticized from a statistical angle it is hoped that it reflects an enquiry from which others may perhaps find some clues to the aetiology of glaucoma which have eluded the author.

As this paper may be read by physicians a brief résumé of the condition may be appropriate. Glaucoma is an acute or chronic condition characterized by, but not invariably associated with, raised ocular tension. In acute inflammatory conditions, notably uveitis, drainage of aqueous is readily obstructed at the narrowed angle, but in the common primary simple glaucoma the angle is usually normal, even wide, as seen by gonioscopy and the mechanism of raised ocular tension remains obscure. Duke-Elder (1957) described simple glaucoma as "an insidious and slowly progressive disease characterized in its complete form by a triad of symptoms—field defects, cupping of the disc, and an instability or increase in the ocular tension, which although often initially phasic, eventually tends to be permanent, but nevertheless is sometimes insignificant and often absent. It occurs usually in the sixth and seventh decades of life without predilection for either sex in eyes of any type or of any width of angle".

The normal ocular tension averages 16 mm. Hg (Schiötz). A tension of 25 mm. is usually abnormal and 28 mm. is always abnormal. There is a diurnal variation which has special interest; the tension is usually highest at 5–7 a.m. and falls in the afternoon. A normal eye shows only 2–5 mm. variation but a glaucomatous eye may show up to 30 mm. variation. Recent mass screening for glaucoma (Leydhecker, 1961) suggests that any individual with tension over 20 mm. Hg should be completely examined. Simple glaucoma was found in 2·3 per cent. of adults over 40 years of age in screening 10,000 subjects.

Method of Study

Patients attending the Glaucoma Clinic at the Institute of Ophthalmology, London, were referred for general medical assessment. A history was taken on a standard form covering

* Received for publication August 3, 1965.

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all the systems and read in conjunction with the ophthalmic history. Habits, occupation, social situation, and family history were included.

The physical examination was detailed for each system but particular care was taken in the cardiovascular system since this was thought from the start of the investigation to be the most fruitful. An electrocardiogram was invariably taken and an x-ray film of the chest obtained in the great majority. The urine was examined for specific gravity, albumen, and sugar. Other tests performed in some cases but not as a routine included blood count, blood sugar, serum urea, cholesterol, and Wassermann reaction, where appropriate.

An attempt was then made to crystallize the important features of each patient, having regard to possible aetiological factors for the glaucoma, in a short statement, *e.g.*:

Male 70. Primary simple glaucoma. Good condition having taken stilboestrol for 10 years after operation for carcinoma of prostate ? fluid imbalance.

or

Female 59. Primary simple glaucoma. Very nervous, depressed with forebodings, asthmatic, migrainous, bronchitic. Children have tuberculosis. Leukomelanoderma.

or

Female 54. Primary simple glaucoma. Perfectly healthy apart from eyes.

or

Male 67. Primary simple glaucoma. Spare hypertensive patient with emphysema and nervous dyspepsia.

These examples illustrate at once the difficulties in evaluating the possible role of systemic states in the aetiology of glaucoma.

Results

The classification of glaucoma for ophthalmic needs is too complicated for our purpose and the following was used as a compromise: (A) primary simple, (B) primary congestive, (C) secondary and other, and (D) no glaucoma after initial diagnosis of glaucoma.

Some mixed cases, simple glaucoma becoming congestive or "closed-angle", were classified as simple, and doubtful chronic cases were also included in the simple type. There were eight such cases. Patients who were later thought not to have glaucoma after the initial diagnosis were assessed in the same way (Table I).

TABLE I
CLASSIFICATION

Type of Glaucoma		No. of Cases	
A	Primary simple	173	
B	Primary congestive	9	78
	Acute Subacute and chronic	69	
C	Secondary and Other	6	27
	Inflammatory	3	
	Traumatic, foreign body, and cataract operation	1	
	Thrombotic	1	
	Juvenile	2	
	Capsular	5	
	Posner-Schlossman syndrome	1	
	Other	9	
D	No glaucoma	22	
Total		300	

Age and Sex.—Of the 300 patients, roughly two-thirds were male and one-third female. Only Group C showed a larger proportion of males. In Group A the average age for males was 61.14 and the average age for females 62.64 years. There were only twenty patients under 40 years old (Table II).

TABLE II
AGE AND SEX OF 300 PATIENTS

Type of Glaucoma		No. of Cases	Sex		Age Group (yrs)							
			Male	Female	20-29	30-39	40-49	50-59	60-69	70-79	80-89	Average
A	Primary simple	173	131	42	0	7	12	47	64	42	1	61.6
B	Primary congestive	78	51	27	0	2	20	22	28	6	0	56.7
C	Secondary and Other	27	23	4	5	2	5	4	8	3	0	51.6
D	No glaucoma	22	16	6	3	1	6	2	5	5	0	53.2
Total		300	221	79	8	12	43	75	105	56	1	58.8

Duration of Ocular Symptoms at Time of Medical Assessment.—Just over half the patients in each group had had symptoms under 2 years (Table III).

TABLE III
DURATION OF OCULAR SYMPTOMS AT TIME OF MEDICAL ASSESSMENT

Type of Glaucoma		No. of Cases	Duration of Symptoms (yrs)																	
			-1	1+	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A	Primary simple	173	74	29	21	17	12	4	4	2	2	0	4	1	1	1	0	0	1	0
B	Primary congestive	78	29	13	9	7	6	1	2	1	2	2	1	0	0	1	0	1	0	1
C	Secondary and Other	27	10	8	1	1	0	0	1	0	0	2	2	1	0	0	0	0	0	1
D	No glaucoma	22	10	3	1	2	0	2	1	0	0	0	3	0	0	0	0	0	0	0
Total		300	123	53	32	27	18	7	8	3	4	4	10	2	1	2	0	1	1	0

Visual Acuity.—One-third of the total had normal visual acuity in the better of two eyes (Table IV, overleaf).

Ocular Tension.—About half the patients had raised tension in either eye, except of course in Group D (Table V, overleaf). The one operation in Group D was for cataract.

Healthy Patients with Glaucoma ("Normals").—Thirteen patients were studied who seemed healthy apart from glaucoma. These patients appeared free from cardiovascular disease symptomatically, *i.e.* they had no angina or intermittent claudication or dyspnoea and no Raynaud's phenomenon, recent faints, or headaches before the onset of glaucoma, normal blood pressure up to 160/100, no physical signs of arteriosclerosis or heart disease, normal electrocardiogram and heart size (a few did not have x-rays); no chronic bronchitis or emphysema clinically or radiologically; no diabetes or thyrotoxicosis and no albuminuria;

TABLE IV
VISUAL ACUITY

Type of Glaucoma		No. of Cases	Visual Acuity			
			Normal		Moderate	Poor
			No.	Per cent.		
A	Primary simple	173	47	27.2	121	5
B	Primary congestive	78	34	43.6	43	1
C	Secondary and Other	27	7	25.9	19	1
D	No glaucoma	22	11	50.0	10	1
Total		300	99	33.0	193	8

TABLE V
OCULAR TENSION*

Type of Glaucoma		No. of Cases	Raised Tension > 28 mm. Hg		No. with Normal Tension	Effects of Surgery		
			No.	Percentage of Group		No. Operated on	After Surgery	
							Normal Tension	Persistent Raised Tension
A	Primary simple	173	91	52·6	82	36	21	15
B	Primary congestive	78	38	48·7	40	32	18	14
C	Secondary and Other	27	13	48·1	14	10	6	4
D	No glaucoma	22	2	9·1	20	1	1	0
Total		300	144	48·0	156	79	46	33

* Readings from tonometers other than Schiötz were converted to equivalent Schiötz.

and no allergy. Five patients had had operations for glaucoma, two of them for simple glaucoma. One had cervical spondylosis and another had had a pyrexia of unknown origin at age 13 for many months.

The occupations of these thirteen patients were as follows:

housewife (4), bus driver (1), chemist (1), factory planner (1), machinist (1), tailor's cutter (1), engineer (1), salesman (1), postman (1), garage director (1).

The average age of these normal patients was lower than that for the whole series. Presumably cardiovascular disease would appear as some of these normal patients aged.

Table VI (opposite) deals with the groups in which these "normals" were found. In Group A only one smoked $\frac{1}{2}$ oz. pipe tobacco a day and the four others did not smoke at all. In Group B, four of five smoked moderately. There were no heavy drinkers and alcohol was taken to a moderate extent by only one patient. There were three teetotallers in the whole series. There were no patients who were both non-smokers and teetotallers.

TABLE VI
"NORMALS"*

Type of Glaucoma		Total No. of Cases	Average Age (yrs)	"Normals"												
				Sex			Average Age (yrs)			Smoking				Alcohol		
Total	M.	F.	Total	M.	F.	Nil	Slight	Moderate	Great	Nil	Slight	Moderate				
A	Primary simple	173	61.6	5	2	3	54	57	53	4†		1		0	5	0
B	Primary congestive	78	56.7	5	4	1	47	48	46		1	4		3	1	1
C	Secondary and Other	27	51.6	2	2	0	33	33	—		1	1		0	2	0
D	No glaucoma	22	53.2	1	1	0	39	39	—				1	0	1	0
Total		300	58.8	13	9	4	47	46	51	4	2	6	1	3	9	1

* See also Table XVI

† 2 males, 2 females

Bronchitis and Emphysema. Chronic bronchitis and emphysema was found in every other patient in Group C and rather less often in Groups A and B (Table VII). While the patients were Londoners and in the older age groups, this incidence is high especially in view of the relatively low smoking rate. But the other half or more patients had no bronchitis or emphysema, so that this condition could be only an aggravating cause of glaucoma. Carbon dioxide retention could stimulate the formation of aqueous as it does of cerebrospinal fluid, but in general the bronchitis and emphysema was not severe enough to cause much CO₂ retention. Overy (1963)

showed during a 24-hour investigation in emphysematous subjects that the arterial PCO₂ rose at about 4 a.m. and was lowest between 2 and 8 p.m., whereas arterial oxygen saturation was lowest at 4 a.m. and highest in the late afternoon. This bears a close time-relationship with the diurnal changes in ocular tension. Three special factors could operate to a variable degree at 4 a.m. when ocular tension is highest, *i.e.* lowest blood pressure, highest arterial PCO₂, and lowest arterial oxygen saturation. If the filtration angle system is impaired congenitally or from fibrosis, ischaemic, or otherwise, then the circulatory stagnation from low blood pressure and low oxygen saturation would interfere with the *vital* process of filtration, while a high PCO₂ stimulating production of aqueous would also aggravate ocular tension at that time. In normal subjects slighter diurnal changes occur in the same direction with blood pressure (Blankenhorn and Campbell, 1925) and with PCO₂ and PO₂ though arterial oxygen saturation is not altered (Robin, Whaley, Crump, and Travis, 1958). Trutneva (1961) found the arterial oxygen saturation level decreased in 72 of 122 glaucoma cases, using a cathode oximeter.

The favourable action of acetazolamide in glaucoma is partly explained by its inhibition of carbonic anhydrase which normally produces bicarbonate from CO₂. Bicarbonate makes aqueous hypertonic osmotically (Becker, 1954), hence inhibition of its formation may

TABLE VII
BRONCHITIS AND EMPHYSEMA

Type of Glaucoma		No. of Cases	With Bronchitis	
			No.	Per cent.
A	Primary simple	173	76	43.9
B	Primary congestive	78	35	44.8
C	Secondary and Other	27	14	51.8
D	No glaucoma	22	6	27.3
Total		300	134	43.7

be beneficial (Perkins, 1955). At the same time acetazolamide reduces arterial PCO_2 .

Blood Pressure.—Just under half the patients had a blood pressure of over 160/100. This proportion is more than expected from the general population, but Table VIII shows what has been generally accepted as applicable to the glaucoma groups.

TABLE VIII
BLOOD PRESSURE

Type of Glaucoma		No. of Cases	Average Age (yrs)	Blood Pressure				
				Average	Up to 160/100		Over 160/100	
					No. of Cases	Average	No. of Cases	Average
A	Primary simple	173	61.6	169/96	84	142/89	89	195/105
B	Primary congestive	78	56.7	163/95	45	143/87	33	190/104
C	Secondary and Other	27	51.6	155/92	19	134/84	8	209/109
D	No glaucoma	22	53.2	164/97	11	142/89	11	187/105
Total		300	58.8	166/95	159	141/87	141	194/105

Electrocardiograms.—An electrocardiogram was taken in all but two cases (Table IX). Considering the age groups, there was a high percentage of strictly normal or non-significant records, 67.78 per cent. Non-significant changes in the electrocardiogram included extrasystoles, sinus arrhythmia, moderate sinus tachycardia, high voltage T waves, and simple left axis deviation of postural origin, as in obesity. There were only two cases of atrial fibrillation and one of paroxysmal tachycardia. Changes due to emphysema were

TABLE IX
ELECTROCARDIOGRAPHIC FINDINGS

Type of Glaucoma		No. of Cases	ECG Findings							
			Total	Normal or Non-significant		Disorders of Rhythm excluding HB	Emphysema	Miscellaneous	Ischaemia and LVH	
				No.	Per cent.				HB and BBB	LAD
A	Primary simple	173	172	112	65.1	0	11	0	37	12
B	Primary congestive	78	77	56	72.7	3	3	1	10	5
C	Secondary and Other	27	27	17	63.0	0	0	0	5	4
D	No glaucoma	22	22	17	77.3	0	0	0	2	3
Total		300	298	202	67.8	3	14	1	54	24

ECG = electrocardiogram
HB = heart block
BBB = bundle branch block
LAD = left axis deviation

seen in fourteen patients and one other patient showed myxoedematous changes. The remaining abnormalities consisted of ischaemic changes including heart block and bundle branch block, and left ventricular hypertrophy which is often difficult to differentiate from ischaemic changes. 54 patients were included in that group. 24 patients in the total series showed left axis deviation only, which was thought in these cases probably to represent left ventricular hypertrophy and not simply a postural change. The last two groups of 78 patients (54 + 24) accounted for 26.00 per cent. of the total series—about one-quarter, or 81.25 per cent. of those showing abnormal records.

Non-hypertensive Cardiovascular Disease.—There were two rheumatic hearts and one case of cor pulmonale.

Evidence of arteriosclerosis included angina, electrocardiographic ischaemic changes without angina, and abnormal arteries in the lower limbs with or without intermittent claudication or with evidence of aortic valve atheroma whether clinical or radiological. If we add to the hypertensive group those non-hypertensives with arteriosclerosis, the incidence of cardiovascular abnormality of that aetiology is very high in all groups (Table X).

TABLE X
NON-HYPERTENSIVE CARDIOVASCULAR DISEASE

Type of Glaucoma		(a) No. of Cases	(b) Non- hypertensive in (a)	(c) Arterio- sclerosis in (b)	(d) Hypertensive	(c) + (d)	
						No.	Percentage of Whole Series
A	Primary simple	173	84	27	89	116	67.1
B	Primary congestive	78	45	8	33	41	52.6
C	Secondary and Other	27	19	2	8	10	37.0
D	No glaucoma	22	11	3	11	14	66.6
Total		300	159	40	141	181	60.3

Urinalysis.—The rarity of diabetes was striking (Table XI). All four diabetics were of the elderly type and only one was on insulin treatment. All were hypertensive.

TABLE XI
URINE ANALYSIS

Type of Glaucoma		No. of Cases	No. in whom Urine was Tested	Findings	
				Diabetes	Albuminuria
A	Primary simple	173	167	3	5
B	Primary congestive	78	75	0	0
C	Secondary and Other	27	27	1	0
D	No glaucoma	22	21	0	0
Total		300	290	4	5

Albuminuria was also rare, being found in five cases only, all in Group A. Two of these were grossly hypertensive and the other three were at the upper limit of normal blood pressure.

No positive significance can be attached to these findings.

Raynaud's Phenomenon and Headache.—As shown in Table XII the proportion of Raynaud's phenomenon may seem unexpectedly high (about one-third), but the condition was liberally interpreted and there were very few patients who could be classed as suffering from Raynaud's disease and none showed eschars of Raynaud type.

TABLE XII
RAYNAUD'S PHENOMENON AND HEADACHE

Type of Glaucoma		No. of Cases	Raynaud's Phenomenon		Headache	
			No.	Per cent.	No.	Per cent.
A	Primary simple	173	60	34.7	59	34.1
B	Primary congestive	78	28	35.9	28	35.9
C	Secondary and Other	27	8	29.6	10	37.0
D	No glaucoma	22	6	27.3	9	40.9
Total		300	102	34.0	106	35.3

Headache that followed glaucoma was not included. Most headaches were migrainous but a strict analysis was not carried out.

Allergy.—Approximately one in six persons had some allergic manifestation (Table XIII). There was no significant difference between the groups; notably Group B, congestive glaucoma, did not show a higher incidence than the average. Drugs included eserine, atropine, aspirin, penicillin, iodine, sulphur, and "Vic". Foods included fish of various kinds, strawberries, tomatoes, and almonds. Miscellaneous factors were gold-rimmed spectacles and spiders. None of these appeared to be relevant to glaucoma.

TABLE XIII
ALLERGY

Type of Glaucoma		No. of Cases	Hay fever	Drugs	Foods	Urticaria or Dermatitis	Miscellaneous	Total Allergy	
								No.	Per cent.
A	Primary simple	173	11	6	8	4	0	29	16.8
B	Primary congestive	78	3	2	4	3	2	14	17.9
C	Secondary and Other	27	1	1	2	0	0	4	14.8
D	No glaucoma	22	0	2	1	1	0	4	18.2
Total		300	15	11	15	8	2	51	17.0

Emotional State.—Table XIV (opposite) shows no substantial difference between the groups as regards incidence of emotional stress or instability and a nearly equal number was particularly stable in contrast. At most, emotional disturbance can have only an aggravating influence on glaucoma; shock or intense stress such as bereavement did seem at times to precipitate symptoms of glaucoma, but much more often no such factor was involved.

Menopause.—In women showing simple glaucoma (Group A) the onset of the glaucoma occurred in one-third at or near the menopause, and in the other two-thirds 4 years or more

TABLE XIV
EMOTIONAL STATE

Type of Glaucoma		No. of Cases	(a) Anxiety Alone	(b) Anxiety and Systemic Disease	(c) Shock or Stress	(d) Depression	(a) + (b) + (c) + (d)		No. Stable
							No.	Per cent.	
A	Primary simple	173	19	12	12	2	45	26.0	44
B	Primary congestive	78	14	6	4	0	24	30.8	21
C	Secondary and Other	27	2	1	3	0	6	22.2	12
D	No glaucoma	22	2	0	1	1	4	18.2	9
Total		300	37	19	20	3	79	26.3	86

after the menopause at an average age of 63. Group B included a slightly greater proportion at, than after, the menopause (Table XV).

TABLE XV
MENOPAUSE

Type of Glaucoma		No. of Women	(a) No. of Cases with Full Information	(b) Pre-menopause	(c) 1-3 yrs Post-menopause	(b) + (c)	(d) Onset 4 yrs or More after Menopause	Average Age* in Post-menopausal Cases (d) at Onset of Glaucoma
A	Primary simple	42	36	4	5	9	27	63
B	Primary congestive	27	21	10	2	12	9	66
C	Secondary and Other	4	4	1	0	1	3	57
D	No glaucoma	6	5	2	2	4	1	51
Total		79	66	17	9	26	40	63

* Age taken at onset of glaucoma symptoms (not at age when seen).

Tobacco.—Just over one-fifth of all patients did not smoke, and just under two-thirds did not smoke significantly. There was no substantial difference in the various groups (Table XVI, overleaf). The proportion of heavy smokers was small (9.66 per cent.), again with no significant difference between the groups. See also Table VI.

Alcohol.—One-quarter of all patients took no alcohol and over four-fifths took only small amounts, while only 2.66 per cent. drank heavily. There was no significant difference between the groups (Table XVI).

Discussion

Morgan (1958) emphasized the importance of early clinical diagnosis of glaucoma: If one can diagnose simple glaucoma in the first affected eye when there is the earliest indication

TABLE XVI
USE OF TOBACCO AND ALCOHOL*

Type of Glaucoma		No. of Cases	Tobacco								Alcohol			
			Nil		Nil recently	Slight	Moderate	Great	Moderate + Great		Nil	Slight	Moderate	Great
			No.	Per cent.					No.	Per cent.				
A	Primary simple	173	14	13.1	11	57	49	15	64	31.2	41	105	22	5
B	Primary congestive	78	17	21.8	1	32	19	9	28	35.9	24	45	8	1
C	Secondary and Other	27	4	14.8	2	14	5	2	7	25.9	5	19	2	1
D	No glaucoma	22	6	27.3	0	8	5	3	8	36.4	4	14	3	1
Total		300	68	22.7	14	111	78	29	107	35.7	74	183	35	8
											257 (85.7 per cent.)		(2.7 per cent.)	

* See also Table VI

of cupping of the disc, or when in addition there is a suspicion only of some affection of the central field, it is probably true to say (if the appropriate treatment is commenced) that in the majority of cases, that patient will have adequate vision for his working life.

He stated that about 2 per cent. of the $3\frac{1}{2}$ million people over 40 years of age in Great Britain have glaucoma, *i.e.* 60,000. Hence it is important to search for the aetiology.

The pathogenesis of glaucoma is still under discussion, but Ashton (1960) noted:

There is then much evidence to-day in favour of incriminating structural changes in the trabecular meshwork as of possible importance in the pathogenesis of simple glaucoma.

Clearly it is not simply a matter of width of angle that determines proneness to glaucoma. Luntz and Smith (1960) found in four Negroes a degree of fibrosis of episcleral tissue around the limbus leading to obliteration of episcleral veins. Possibly, developmental defects in the outflow tract may be operative, especially in the younger age groups (Perkins, 1960). That there is a strong hereditary influence is suggested by Paterson (1961) and by Miller and Paterson (1962), who thought it worth while studying siblings in case-finding. It was not possible in the present series to study heredity, as information gained from interrogation by a physician was not rewarding.

Leydhecker (1962) thought that central nervous influences on the rate of secretion of aqueous humour were worth noting. He had shown by tonography that a sedative, meprobamate, could repeatedly lower tension. In this series there were many nervous subjects, but glaucoma was equally common in stable subjects. Occasionally stress seemed to determine the onset of glaucoma which was doubtless already latent. Vail (1956) stated that, in inflammatory congestive or narrow-angle glaucoma:

The elevation of ocular tension is episodic and may be precipitated by emotional worry or strain, darkness, menstruation, fatigue, mydriasis by drugs, or on viewing motion pictures; it is relieved by sleep.

Others deny the existence of a glaucomatous personality (Zimet and Berger, 1960).

Racial predisposition to, or immunity from, glaucoma is worth comment: Holmes (1961) found primary glaucoma to be rare among Polynesians, Micronesians,

Indonesians, Melanesians, New Guinea tribesmen, and Australian aboriginals. He ascribed such immunity to more exercise and less social stress. Landau and Halevi (1960) found that oriental Jews have a higher incidence of glaucoma. Patients using cooking oils contaminated with sanguinarine may develop glaucoma (Hakim, Mijović, and Walker, 1961).

Becker and Shaffer (1961) concluded that: there is little or no evidence that limitation of activities, diet, tobacco, alcohol, coffee, fluids, movies, television, reading, driving, etc. alter the course or control of glaucoma patients.

Owing to the prevalence of hypertension among glaucoma patients it is likely that hypotensive drugs will be in use already in some of them when diagnosed. In the early days of hypotensive drugs, hexamethonium did not seem to raise the intra-ocular pressure (Cameron and Burn, 1952), but Duke-Elder (1962) gave a warning in this respect:

All things considered a high diastolic pressure is a good thing; but it is to be remembered that in hypertensive individuals a high systemic diastolic pressure is often associated with a low capillary pressure. The effect of this is seen in the rapid and dramatic worsening of the visual fields which so often occurs when a glaucomatous patient with a high blood pressure is given hypotensive drugs.

Summary and Conclusions

(1) Three hundred patients attending a glaucoma clinic have been assessed from a physician's view point.

(2) Only a few patients (13) seemed to be entirely free from structural or functional disease other than glaucoma.

(3) The incidence of cardiovascular disease and of chronic bronchitis appeared to the author to be higher than is found in the various age groups of the general population, but although an attempt was made to produce a control series it proved impossible and only an impression can be put forward.

(4) The exact mechanism by which an impaired blood supply to the drainage area in simple glaucoma could operate is conjectural, yet impaired function is a very natural result of impaired blood supply.

(5) The repetitive effect of increased venous pressure in chronic bronchitis could in itself impair venous drainage and so promote glaucoma especially when combined with arteriolar narrowing.

(6) Diurnal variations in ocular pressure appear to have a relation to blood oxygen and carbon dioxide values.

(7) When the cardiovascular system is abnormal, vasomotor dysfunction is very readily superadded, hence the occasional precipitation of, or aggravation of, glaucoma by stress.

(8) Glaucoma, like many other diseases of special senses, appears at times to be a purely local disturbance, yet a study of the patient as a whole as in the present work does suggest that systemic disease has in fact a considerable influence in determining the onset, course, and severity of glaucoma, and it behoves us in treatment to give deliberate attention to such general factors. For example, a glaucomatous chronic bronchitic who smokes may benefit much from cessation of smoking, by diminishing cough, improving respiratory function, and reducing vascular tone and ischaemia.

Periodic rest also reduces vascular tone. Special care is necessary in the use of hypotensive drugs for systemic hypertension.

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