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Epidemiological aspects of intraocular pressure in an onchocerciasis endemic area

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A field investigation of intraocular pressure in populations in onchocerciasis endemic areas of West Africa revealed a normal pressure distribution in individuals without signs of ocular onchocerciasis or with only microfilariae or reversible lesions in the eye. Females showed a significantly higher mean ocular tension, and in both sexes tension decreased with age. Patients with irreversible onchocercal ocular lesions and signs of anterior uveitis showed a significantly lower and abnormally distributed intraocular pressure. The prevalence of glaucoma was significantly higher in this group, thus indicating that a high intensity of onchocercal infection may be associated with a risk of secondary glaucoma. The presence of microfilariae in the ocular tissues and consequent inflammatory reactions may possibly give rise to an abnormal distribution of ocular tension.

In parts of Africa where onchocerciasis is endemic, glaucoma has also been observed to be a common cause of blindness. The relationship between these two diseases is still unclear. Glaucoma with an open filtration angle and associated with a light onchocercal infection has been reported in young age groups in rainforest areas in Africa (*4, 5*), and an abnormal distribution of intraocular pressure has been demonstrated in cases of severe ocular onchocerciasis (*10*). Anterior uveitis, which is often associated with ocular onchocerciasis, may provoke secondary glaucoma in long-standing cases, but the epidemiological significance of this is not clear.

The present study was undertaken in order to elucidate the distribution of intraocular pressure in populations living in onchocerciasis endemic areas. The role and importance of glaucoma as a cause of blindness in such populations are discussed.

MATERIALS AND METHODS

Twenty villages in savanna areas of Ghana, Ivory Coast, Mali, Togo, and Upper Volta were surveyed as part of the Onchocerciasis Control Programme in the Volta River Basin Area (of which the World Health Organization is the executing agency). Most of the villages were situated in areas of medium or high onchocerciasis endemicity.

In each village a census was prepared by a sociologist to ensure that the persons examined formed a representative sample of the population. Skin snips were taken from both iliac crests of each subject and were immersed for 30 min in distilled water before being read under the microscope. Negative snips were incubated for another 24 hours in saline solution and verified once again.

The ophthalmological examination took place in a mobile dark-room. After the subject had been positioned with his head down for a minimum of 1 min, the anterior segment of the eye was examined for microfilariae using a slit-lamp (Haag-Streit 900) with a magnification of either 16 × or 25 ×. Local anaesthesia (oxybuprocaine) was administered and the intraocular pressure was measured (right eye first) using the Haag-Streit applanation tonometer. The pupils were then dilated with 1% tropicamide, and the posterior segment of the eye was examined using direct or indirect ophthalmoscopy. Gonioscopy was performed whenever possible in subjects with increased intraocular pressure (more than 25 mmHg (3.3 kPa)).

When corneal disorders made tonometry impossible, digital palpation was used and glaucomatous cupping of the optic discs was looked for. Children less than 5 years old were not examined ophthal-

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mologically, and the intraocular pressure was measured systematically only in individuals aged 10 years or more.

RESULTS

The total population examined consisted of 3795 persons aged 10 years or more, of whom 1836 were males and 1959 were females. It was possible to obtain reliable readings of intraocular pressure in a total of 2861 (75%) of the individuals examined (2813 right eyes and 2776 left eyes). The persons examined were divided into three main groups on the basis of the ocular findings. The first group ("no ocular onchocerciasis") showed no microfilariae in the eyes and no lesions typical of ocular onchocerciasis. This category was further divided into skin-snip negative and skin-snip positive subgroups. The second group ("mild ocular onchocerciasis") had dead or living microfilariae present in the eyes but no irreversible onchocercal lesions. Cases that showed signs of anterior uveitis, defined as visible flare, were analysed separately from the rest of the group. The third group ("severe ocular onchocerciasis") consisted of individuals with severe and irreversible onchocercal ocular lesions—i.e., sclerosing keratitis, onchocercal choroidoretinitis, and/or postneuritic optic atrophy. This last category often includes long-standing cases of onchocerciasis with a high intensity of infection.

The distribution of the subjects in the different categories, according to the findings in the right eye, is shown in Table 1. There were different patterns of distribution by age and sex in the three main groups, ocular onchocerciasis being significantly associated with a higher mean age and a male dominance.[a] The distribution patterns according to the ocular findings were similar for both eyes.

Table 2 shows the mean intraocular pressure for the right and left eyes in the different groups. No significant difference was found between the right and the left eye, but females showed a higher level of ocular tension.

The distribution of intraocular pressure by age is shown in Table 3. The ocular tension was found to decrease significantly with age in all categories. This decrease was similar in both eyes and occurred in both males and females.

The mean intraocular pressure and its variability, as indicated by standard deviation, are shown in Table 4 for each of the groups. The composite group with signs of iritis or severe ocular onchocerciasis showed a different distribution with a significantly lower mean and a higher standard deviation. This is illustrated in Fig. 1, in which this composite group shows a curve that is flatter, with a lower mean tension. This curve also has a skew to the right, in favour of low tension readings, in contrast to the rest of the sample, in which a slight skew to the left is found.

[a] Throughout this paper statistical significance was taken to be at the 5% level.

Table 1. Distribution of subjects in each of the ocular onchocerciasis groups according to ocular findings in the right eye, by age and sex (intraocular pressure ≤ 25 mmHg)

Age group (years)	Sex	No ocular onchocerciasis		Mild ocular onchocerciasis		Severe ocular onchocerciasis	All groups
		Snips negative	Snips positive	Iritis negative	Iritis positive		
10-14	Males	84	68	140	2	3	297
	Females	87	45	75	1	2	210
	Total	171	113	215	3	5	507
15-29	Males	50	91	194	5	45	385
	Females	132	139	200	5	19	495
	Total	182	230	394	10	64	880
30-49	Males	31	105	167	21	134	458
	Females	76	130	218	14	76	514
	Total	107	235	385	35	210	972
≥ 50	Males	22	63	41	14	57	197
	Females	26	64	65	9	42	206
	Total	48	127	106	23	99	403
Total	Males	187	327	542	42	239	1337
	Females	321	378	558	29	139	1425
	Total	508	705	1100	71	378	2762

Table 2. Mean intraocular pressure (mmHg[a]) in the right and left eyes in each of the ocular onchocerciasis groups, by sex (intraocular pressure ≤ 25 mmHg)

Sex	Eye	No ocular onchocerciasis		Mild ocular onchocerciasis		Severe ocular onchocerciasis	All groups
		Snips negative	Snips positive	Iritis negative	Iritis positive		
Males	Right	14.8	14.2	14.1	12.6	12.1	13.8
	Left	14.7	14.3	14.1	11.9	12.0	13.7
Females	Right	15.3	14.4	14.8	13.9	13.4	14.7
	Left	15.4	14.4	14.7	13.4	13.3	14.6

[a] 1 mmHg = 0.1333 kPa.

Table 3. Mean intraocular pressure (mmHg[a]) of the right eye in each of the ocular onchocerciasis groups, by age (intraocular pressure ≤ 25 mmHg)

Age group (years)	No ocular onchocerciasis		Mild ocular onchocerciasis		Severe ocular onchocerciasis	All groups
	Snips negative	Snips positive	Iritis negative	Iritis positive		
10-14	15.9	15.0	15.3	14.0	15.6	15.4
15-29	14.9	14.9	14.7	13.3	13.1	14.7
30-49	14.4	13.9	14.0	13.2	12.5	13.7
≥ 50	14.4	13.7	13.7	12.7	12.3	13.4
Total	15.1	14.4	14.5	13.1	12.6	14.3

[a] 1 mmHg = 0.1333 kPa.

Table 4. Mean intraocular pressure (mmHg[a]), standard deviation and number of subjects in each of the ocular onchocerciasis groups (intraocular pressure ≤ 25 mmHg)

	No ocular onchocerciasis		Mild ocular onchocerciasis		Severe ocular onchocerciasis	All groups
	Snips negative	Snips positive	Iritis negative	Iritis positive		
Mean	15.09	14.35	14.48	13.11	12.58	14.26
Standard deviation	3.05	2.99	3.02	3.97	3.57	3.22
Number of subjects	508	705	1100	71	378	2762

[a] 1 mmHg = 0.1333 kPa.

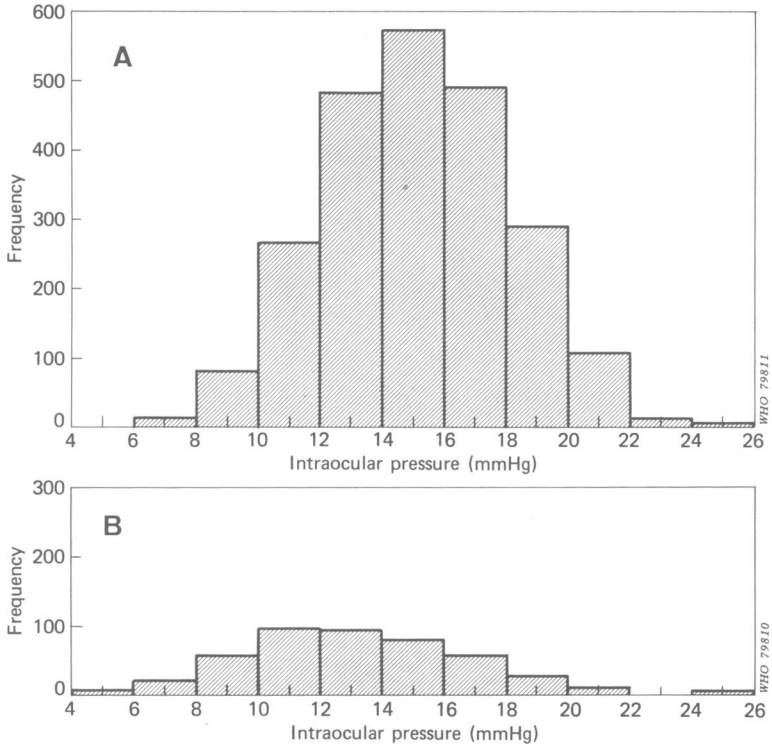

Fig. 1. Intraocular pressure distribution: (A) in subjects without signs of iritis or ocular onchocerciasis; and (B) in subjects with iritis or severe ocular onchocerciasis. 1 mmHg = 0.1333 kPa.

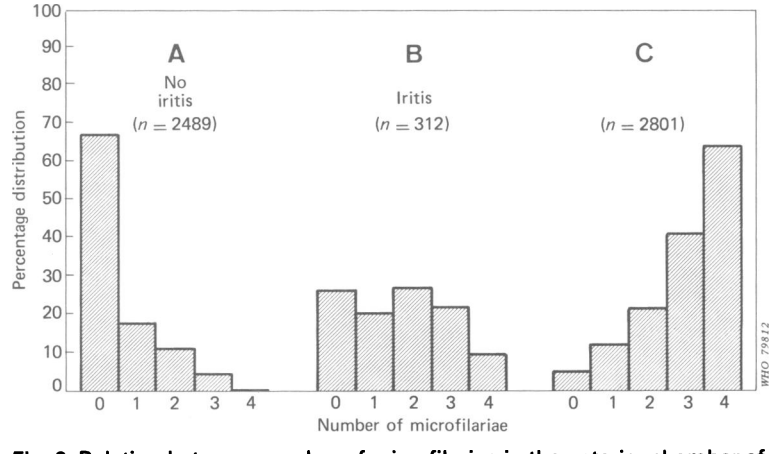

Fig. 2. Relation between number of microfilariae in the anterior chamber of the eye (by categories) and the presence of iritis.
A. Of the people without iritis, proportions in each number category;
B. Of the people with iritis, proportions in each number category;
C. Of the total population examined in each number category, proportions with iritis.
0 = no microfilariae; 1 = 1-4 microfilariae; 2 = 5-19 microfilariae; 3 = 20-49 microfilariae; 4 = ⩾50 microfilariae.

Table 5. Prevalence of glaucoma in each of the main ocular onchocerciasis groups, by age and sex

Age group (years)	Sex	No ocular onchocerciasis		Mild ocular onchocerciasis		Severe ocular onchocerciasis	
15-29	Males	0	(0%)	3	(1.5%)	5	(10.1%)
	Females	1	(0.4%)	1	(0.5%)	0	(0%)
30-49	Males	3	(2.2%)	3	(1.6%)	8	(5.6%)
	Females	2	(1.0%)	6	(2.5%)	2	(2.6%)
≥ 50	Males	5	(5.6%)	5	(8.3%)	8	(12.3%)
	Females	4	(4.3%)	2	(2.6%)	3	(6.7%)
Total (raw)	Males	8	(1.5%)	11	(1.8%)	21	(8.1%)
	Females	7	(1.0%)	9	(1.5%)	5	(3.5%)
	Total	15	(1.2%)	20	(1.7%)	26	(6.4%)
Total[a] (adjusted)	Males	—	(1.5%)	—	(2.2%)	—	(6.8%)
	Females	—	(1.1%)	—	(1.4%)	—	(1.9%)
	Total	—	(1.3%)	—	(1.8%)	—	(4.3%)

[a] Adjusted to the Onchocerciasis Control Programme population.

Fig. 2 shows the relationship between the quantity of living microfilariae in the anterior chamber of the eye and the presence or absence of iritis. An increased number of microfilariae was associated with the presence of iritis, which in turn was found to be correlated with a significant decrease in ocular tension in both sexes and within each group of the sample.

The prevalence of glaucoma, defined as intraocular pressure of more than 25 mmHg (3.3 kPa) and/or typical cupping of the optic disc, is shown in Table 5 by age group and sex. There was no significant difference in the prevalence of glaucoma between the group with no signs of ocular onchocerciasis and the group that showed microfilariae in the eye but had no irreversible onchocercal lesions. However, the group with severe ocular onchocerciasis showed a higher prevalence of glaucoma with a pronounced male dominance. The age distribution of cases indicates that onchocerciasis is associated with the appearance of glaucoma in younger age groups. It should be noted that three cases of raised ocular tension are not included in Table 5, since it was not possible to classify the ocular lesions.

Table 6. Gonioscopy findings in 22 cases of glaucoma

Presence of anterior synechiae	No ocular onchocerciasis	Ocular onchocerciasis	
		Mild	Severe
Scanty	1	3	2
Numerous[a]	0	4	6
Number of cases	7	7	8

[a] Estimated to cover more than 50% of the circumference of the chamber angle.

In Table 6 the gonioscopy findings of 22 cases of glaucoma are summarized. Ocular onchocerciasis seems to be associated with the presence of peripheral anterior synechiae, and therefore angle closure, but the number of cases available was insufficient for reliable conclusions to be drawn.

DISCUSSION

The applanation tonometry was in general well accepted by the population examined, but lack of cooperation or the presence of advanced corneal disorders made tonometry unreliable or impossible in 25% of the sample. However, attention was paid to other signs of glaucoma and there was no overall bias in the composition of the population examined by tonometry. The technique used for examining the anterior chamber of the eye for the presence of microfilariae, involving the positioning of the patient's head, may have had an influence on ocular tension, but the same procedure was used throughout. Other factors, such as the time of day or the season of the year when the examination is conducted, may affect intraocular pressure (*3*); however, all examinations in this study were carried out during the local dry season (November–May) and no selection of patients by time of day was ever done.

The distribution of intraocular pressure in the group without signs of ocular onchocerciasis corresponds to the findings of previous studies (*2, 3*).

However, it should be noted that this group does not necessarily constitute a normal population because of the possibility that light inapparent onchocercal infections result in lower tensions. The fact that mean tension in the skin-snip negative group tended to be somewhat higher than in the skin-snip positive may be a reflection of this phenomenon. There is no significant difference in tension between the right and the left eye in the present study. This is in accordance with some previous findings (*3*), but other workers have found a higher tension in the right eye—the first to be examined (*2*). The finding that females have a significantly higher intraocular pressure than males is as expected, but in this population ocular tension decreases significantly with age, whereas other workers have found an increase in tension in the older age groups (*3*). However, long-term follow-up studies in other populations have demonstrated a similar decrease in tension with age (*6*).

A high prevalence of anterior uveitis in cases of ocular onchocerciasis has been observed, especially in savanna areas (*1*). Severe ocular lesions of onchocerciasis were strongly associated with the presence of anterior uveitis in the present study, and the probable influence on the distribution of ocular tension has been demonstrated (*10*). The groups showing signs of uveitis and/or severe onchocercal ocular lesions had a significantly lower mean tension, and the distribution curve was flattened out. There was no real difference in tension between the two groups, thus indicating that the uveitis alone was responsible for the difference in distribution.

It is believed that the anterior uveitis in onchocerciasis may sometimes give rise to secondary glaucoma. The presence of microfilariae in the anterior segment of the eye probably causes inflammatory reactions that result in peripheral anterior synechiae, thus obstructing the outflow of aqueous. In the present study the number of glaucoma cases found in the group with severe ocular onchocerciasis was significantly greater than in the group with no ocular onchocerciasis, whereas in the mild ocular onchocerciasis group it was only slightly higher. The severe anterior segment lesions of onchocerciasis are generally associated with large numbers of microfilariae in the eye (*11*), and it therefore seems that secondary glaucoma in onchocerciasis may represent a sign of high intensity of infection. This is further supported by a very pronounced male dominance for glaucoma in onchocerciasis, males usually being more heavily infected than females.

Concerning the prevalence of glaucoma reported in this study, it should be noted that the selected sample from areas of high onchocerciasis endemicity renders difficult direct comparisons with previous glaucoma surveys (*7*). However, the high prevalence of glaucoma associated with severe ocular onchocerciasis, especially in young males, indicates that glaucoma may constitute an important additional risk factor of blindness in onchocerciasis endemic areas.

The pathogenesis of glaucoma in onchocerciasis is still not fully known. The prevalence of glaucoma in rainforest areas seems to be higher than in savanna areas, especially in the younger age groups (*4, 7*). The role of onchocerciasis in lightly infected cases with open-angle glaucoma (*5*) is difficult to assess since primary glaucoma is also prevalent. It has been observed that even minor anterior uveitis may be associated with glaucoma in young onchocerciasis patients (*9*), possibly as a result of dead microfilariae causing congestion of the filtration angle (*8*). In conformity with the known distribution of microfilariae in the anterior segment of the eye (*12*), microfilariae may well be present in the trabeculae, giving rise to an obstruction of the aqueous outflow. Furthermore, tonography has revealed that the outflow facility in patients with heavy onchocercal infections is often low.[b] However, the existence of a low intraocular pressure in eyes with low outflow facility reported by Maertens indicates the possibility of atrophy of the ciliary body in onchocerciasis, and thus a decreased production of aqueous.

It was possible to carry out only a limited number of gonioscopy examinations in the present study, primarily owing to lack of cooperation on the part of the subjects or to the presence of advanced corneal pathology in many glaucoma cases. However, the findings from the 22 glaucoma cases in whom gonioscopy was carried out indicate that ocular onchocerciasis, particularly in its severe form, is associated with the presence of peripheral anterior synechiae and angle closure.

From the epidemiological point of view, it seems that glaucoma associated with ocular onchocerciasis in savanna areas represents a late and serious sign of long-standing and severe disease. In most instances ocular pathology is already advanced by the time that glaucoma develops, and therefore systematic screening for the early detection of such cases would be of only limited value.

[b] Maertens, K. *Tonography in onchocerciasis* (paper presented at the Pan-African Congress of Ophthalmology, Dakar, November 1978; unpublished).

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RÉSUMÉ

LA PRESSION INTRA-OCULAIRE: ASPECTS ÉPIDÉMIOLOGIQUES DANS UNE RÉGION D'ENDÉMIE ONCHOCERQUIENNE

La pression intra-oculaire des habitants de régions d'Afrique occidentale où l'onchocercose sévit à l'état endémique a été contrôlée au moyen de la tonométrie par aplanation sur un total de 2861 individus. La population examinée a été divisée en trois groupes d'après le degré d'atteinte oculaire. Dans le groupe de sujets dépourvus de tout signe d'onchocercose oculaire, la tension intra-oculaire avait une distribution normale, la pression moyenne étant plus élevée dans le sexe féminin. Elle diminuait dans les deux sexes en fonction de l'âge. Les sujets dont les biopsies cutanées exsangues ne montraient la présence d'aucune microfilaire avaient une pression moyenne plus élevée que ceux chez lesquels la recherche était positive. Le second groupe de cas (présence de microfilaires dans les yeux sans lésion irréversible) montrait une distribution similaire de la pression mais une tension oculaire plus faible chez les malades présentant des signes d'uvéite antérieure. Le dernier groupe (lésions d'onchocercose oculaire grave et irréversible) avait une pression intra-oculaire plus faible que les deux autres groupes, avec une courbe de distribution de la pression déviée vers la droite.

La prévalence du glaucome était sensiblement plus élevée dans le groupe à lésions oculaires sévères, avec un taux global ajusté de 4,3% contre 1,3% dans le groupe n'ayant pas de signe d'onchocercose oculaire. Il semble donc qu'une infection onchocerquienne de forte intensité comporte un risque de glaucome secondaire. Les résultats de la gonioscopie dans 22 cas de glaucome indiquent que l'onchocercose oculaire, surtout dans sa forme grave, peut provoquer des synéchies antérieures périphériques et une tendance à la fermeture de l'angle irido-cornéen. L'importance de la charge oculaire en microfilaires, sa répartition dans le segment antérieur, et le rôle d'une uvéite antérieure dans la répartition de la pression et dans les glaucomes secondaires subséquents sont discutés.

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