

HOLGER EHLERS

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## THE PRESSURE LOWERING EFFECT OF ASCORBIC ACID IN OCULAR HYPERTENSION

BY

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In previous studies I reported that ascorbic acid produced a fall in the intra-ocular pressure of about 2 mm Hg<sup>4, 5, 6, 7</sup>. The pressure-lowering effect was obtained after oral administration and also after topical application. The fall in pressure took place about two days following the administration of ascorbic acid. So far normal human eyes and a few glaucomatous eyes have been studied.

In the first study of normal human eyes there was found to be a slight numerical increase in the facility of outflow of about 15 per cent. The reduction in the outflow pressure of about 50 per cent could hardly be entirely explained by these tonographic changes. Other possible mechanisms were therefore discussed. A reduction in the rate of aqueous flow was considered to be the most likely explanation. In further studies the results obtained by means of the suction cup technique indicated a diminished increase in pressure and volume during treatment with ascorbic acid. These results supported the explanation that the pressure fall was caused by a reduction in the rate of aqueous flow. This is however true only under the assumption that no other pathways exist by which the aqueous humour can leave the eye. A bulk drainage by way of uveo-scleral routes in addition to the conventional routes as reported by Bill<sup>2</sup> cannot be excluded although such pathways have not been demonstrated in human eyes. According to this suggestion an increase in the drainage through the posterior part of the eye might occur if the hyaluronic acid in the posterior part of the eye was depolymerized by the high concentration of ascorbic acid.

The purpose of the present study was to investigate the effect of ascorbic acid on a group of human beings with ocular hypertension. In these cases the intraocular pressure was 20-25 mm Hg and the outflow pressure about 10-15 mm Hg instead of about 5 mm Hg at normal pressure levels.

## Material and Methods

The individuals in this study belonged to a group in whom moderate ocular hypertension was detected. They have been kept under observation for five years without treatment. Two reports concerning this follow-up were published<sup>8,9</sup>.

One group of 25 subjects with an average age of 63 years was first examined by tonography without treatment. A new tonographic examination was then carried out after administration of ascorbic acid by mouth, 0.5 gm four times a day for six days. The mean of the two eyes was used in all calculations as a representative value for each individual. The difference between the values during and before treatment was calculated for each individual.

In a separate group of 19 subjects with an average age of 63 years the intraocular pressure was measured by means of the same electronic tonometer and recorder. A 10 per cent aqueous solution of ascorbic acid was given topically in one eye three times a day for 3 days and the other eye was used as a control.\* The right and the left eye were treated in alternate subjects. The effect of the treatment was calculated for each individual as the change in the difference between the test eye and the control eye following topical application of ascorbic acid. The differences are greater in ocular hypertension than in eyes with normal pressure.

A certified Schwarzer's electronic tonometer and a Philips recorder were used. The right eye was always examined before the left one. The facility of outflow was calculated on the first four minutes of the tracing using Friedenwald's table of 1955. Benoxinate 0.4 per cent (Novesin, Wander, Berne) was used as a local anaesthetic.

## Results

Following oral treatment with ascorbic acid a significant fall in the intraocular pressure of 1.10 mm Hg was found, but no significant change in the facility of outflow was observed (Table 1).

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\* These drops were kindly prepared by AB Hässle, Göteborg, Sweden.

Table 1.

Effect of ascorbic acid on intraocular pressure (Schiötz) ( $P_o$ ) and facility of outflow (C) in 25 subjects with ocular hypertension. 0.5 gm ascorbic acid was given four times a day by mouth for 6 days.

		Before ascorbic acid I	During ascorbic acid II	Difference II - I
$P_o$	$\bar{x}$	23.3	22.2	$\div$ 1.10
	$s_{\bar{x}}$	0.71	0.69	0.299
C	$\bar{x}$	0.23	0.20	$\div$ 0.024
	$s_{\bar{x}}$	0.015	0.014	0.0098

In comparison to the difference between the two eyes before treatment the pressure value was significantly lower in the test eye than in the control eye during treatment with eye drops of ascorbic acid, the change being 1.19 mm Hg (Table 2).

The pressure lowering effect was of the same order of magnitude following systemic and topical treatment with ascorbic acid.

### Discussion

The fall in pressure previously demonstrated in normal human eyes was also found in the subjects with ocular hypertension in this study. The effect was of

Table 2.

Effect of 10 % ascorbic acid given topically 3 times daily during 3 days on the intra-ocular pressure (Schiötz) in 19 individuals with ocular hypertension.

	Before ascorbic acid		Ascorbic acid		Difference (III - IV) - (I - II)
	Test eye I	Control eye II	Test eye III	Control eye IV	
$\bar{x}$	23.7	23.1	22.8	23.4	1.19
$s_{\bar{x}}$	0.97	1.02	0.97	1.05	0.346

the same order of magnitude in spite of a marked difference in outflow pressure. The tonographic values of outflow facility were not significantly changed. These results are further evidence in support of the view that the fall in pressure could not be explained by a change in the outflow facility.

The findings in this study confirm the conclusion that the fall in pressure could be caused by a reduction in the rate of aqueous flow, or as another possibility which cannot be excluded by bulk drainage by way of posterior uveo-scleral routes. At the moment there is no way of distinguishing between a change in a pressure-independent uveo-scleral drainage and a change in the rate of aqueous flow entering the anterior chamber in human eyes.

In a paper by Gnädinger and Willome<sup>3</sup> the effect of topical application of a 10 per cent solution of ascorbic acid was examined. According to their figures there was a difference of 1.5 mm Hg in the mean value before and during application of ascorbic acid; in the control eye this difference was 0.57 mm Hg. The authors reported that the treated and the untreated eye did not differ significantly, but they did not present the differences within each individual. The mean value of the fall in pressure was about 1 mm Hg greater in the treated eye than in the control eye and this effect is of the same order of magnitude as the results in the present study.

In a review Bietti<sup>1</sup> reported different studies concerning the pressure reducing effect of ascorbic acid. Doses as high as 0.1 to 0.5 gram per kilogram body weight were given by mouth or 0.4 to 1.0 gram per kilogram intravenously. A marked fall of the intraocular pressure was observed within a few hours. This result was considered to be caused by an osmotic effect at least in rabbits. Other possible pressure-reducing mechanisms were also investigated by using tonography. In most of the cases a diminished formation of aqueous humour rather than a decrease in the outflow resistance was considered to play a role although the possibility of the resistance being reduced was not completely excluded in some cases. Their conclusion that the tonographic evidence speaks in favour of a decrease in the rate of aqueous flow rather than a change in outflow facility is in agreement with my findings.

### Summary

The effect of ascorbic acid on human beings with ocular hypertension was examined.

Following oral treatment with 2 gram of ascorbic acid daily for 6 days the intraocular pressure decreased significantly 1.10 mm Hg but no significant change in the facility of outflow was observed. Following topical administration

of ascorbic acid the pressure in the test eye was significantly lower than the pressure in the control eye in comparison to the difference between the two eyes before treatment.

The findings in this study confirm the conclusion that the fall in pressure could be explained by a reduction in the rate of aqueous flow or as another possibility which cannot be excluded by bulk drainage by way of posterior uveo-scleral routes.

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