

Aqueous humour and serum zinc and copper concentrations of patients with glaucoma and cataract

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Abstract

Serum and aqueous humour zinc and copper concentrations of 44 patients with glaucoma and cataract were determined. Serum values were found within normal ranges. The highest mean copper concentration was seen in the glaucoma group. In addition there was a significant negative correlation between the aqueous humour levels of zinc and copper in patients with glaucoma. It was concluded that an increased copper value together with a low zinc value might be of importance in patients with glaucoma.

Zinc and copper are essential trace elements and are present in ocular tissues.¹ That zinc and copper are needed for the growth and well-being of both plants and animals is well established. The metabolic functions of these elements are largely based on their presence in metallo-enzymes.² Trace element investigations in the aqueous humour have been carried out in animals.^{3,4}

In this study we aimed to determine the aqueous humour zinc and copper levels of patients with cataract and glaucoma and to look for any correlation between these values.

Materials and methods

The study included 44 patients - 20 with senile cataract, 10 with glaucoma, 8 with glaucoma + cataract, and 6 with congenital cataract.

Sterile disposable syringes and hypodermic needles were used to collect blood and aqueous humour samples. The aqueous humour sample was taken during the operation after incision of the conjunctiva and just before opening the anterior chamber. Blood was centrifuged to obtain serum. All samples were immediately stored at -20°C until analysed. All measurements were made with the GBC Scientific Equipment atomic absorption spectrophotometer (Model 902), with copper and zinc hollow cathode lamps at 0.5 slit width and graphite furnace.

The results were analysed by Kruskal-Wallis

variance analysis, unpaired *t* test, and correlation analysis.

Results

The results obtained for human aqueous humour zinc and copper concentrations are given in Table 1. Distribution diagrams are given in Figures 1 and 2.

The mean serum zinc concentrations in all groups were within the normal range of our laboratory (0.8-1.4 µg/ml (12.2-21.4 µmol/l)), whereas copper concentrations were slightly higher (0.9-1.60 µg/ml (14-25 µmol/l)). But no significant difference was found among the groups for both zinc and copper. The highest mean aqueous humour copper concentration was found in the group of glaucoma patients. By analysis of variance a significant difference was found among the groups ($p < 0.05$) for aqueous humour copper concentrations, but not for zinc. The difference was observed only between the mean aqueous humour concentrations of patients with glaucoma or senile cataract. In addition, correlations were established for aqueous humour, but not serum, between zinc and copper (in the group of glaucoma patients $r = -0.755$, $p < 0.01$ and in the group of patients with glaucoma + cataract $r = -0.806$, $p < 0.01$) (Fig 3).

Discussion

We could not find any reports on the trace element concentrations in aqueous humour of patients with cataract and glaucoma. Gerhard *et al*⁵ found the zinc concentrations as 0.27-0.44 µg/ml (4.1-6.7 µmol/l). Moster *et al*⁶ found

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Table 1 Zinc and copper concentrations (arithmetic mean and standard error of mean)

Group	n	Zinc, mean (SEM) (µg/ml)		Copper, mean (SEM) (µg/ml)	
		Aqueous humour	Serum	Aqueous humour	Serum
I. Senile cataract	20	0.144 (0.010)	1.37 (0.071)	0.047 (0.006)	1.85 (0.154)
II. Glaucoma	10	0.154 (0.020)	1.26 (0.126)	0.112 (0.024)*	1.94 (0.183)
III. Glaucoma + cataract	8	0.122 (0.018)	1.42 (0.099)	0.068 (0.015)	1.78 (0.247)
IV. Congenital cataract	6	0.178 (0.042)	1.22 (0.098)	0.070 (0.028)	1.80 (0.289)

*Significantly different from group I at $p < 0.05$.

SI conversion: Zinc µg/ml × 15.3 = µmol/l. Copper µg/ml × 15.7 = µmol/l.

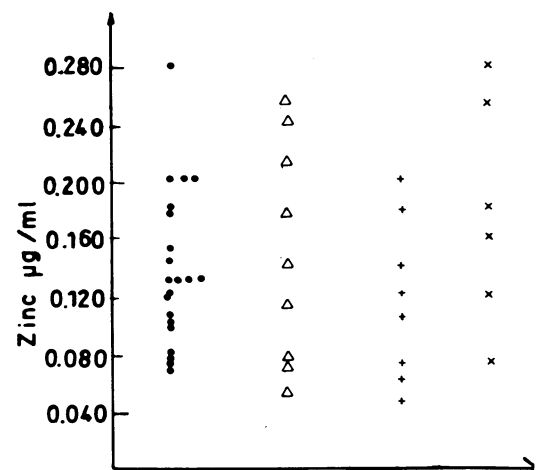


Figure 1 Distribution diagram for aqueous humour zinc concentrations (●: senile cataract, △: glaucoma, +: glaucoma + cataract, ×: congenital cataract). SI conversion: µg/ml × 15.3 = µmol/l.

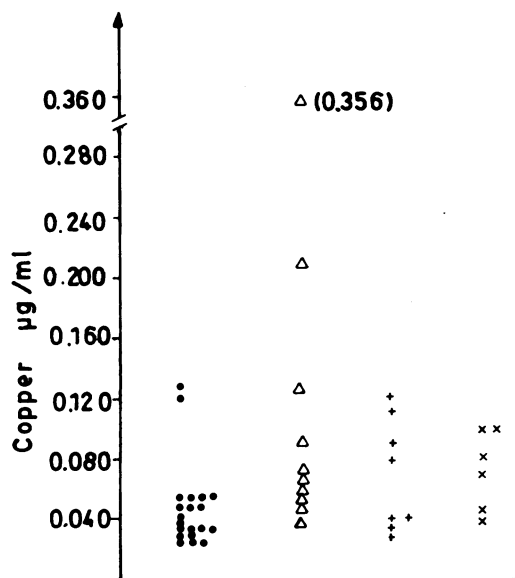


Figure 2 Distribution diagram for aqueous humour copper concentrations (legends as for Figure 1). SI conversion: $\mu\text{g/ml} \times 15.7 = \mu\text{mol/l}$.

the copper concentration to be 0.018–0.080 $\mu\text{g/ml}$ (0.28–1.3 $\mu\text{mol/l}$) in the aqueous humour of normal human subjects. In the present study, for the patients with cataract and glaucoma, we observed higher copper and lower zinc concentrations than the values noted above. In general, copper and zinc are reported to be metabolic antagonists.²⁷ This supports the negative correlation which we have found between the copper and zinc concentrations in the aqueous humour of the patients with glaucoma. A high copper level together with a low zinc level may be caused by the following factors: (1) abnormalities in the secretion of aqueous humour⁵; (2) difficulties in the outflow of aqueous humour through canal of Schlemm⁸; and (3) breakdown of the blood-aqueous humour barrier as a result of trauma, infection, and inflammation.⁹ In normal circumstances it was found that the blood-ocular barrier effectively excludes a potentially toxic excess copper from the eye.⁴ Breakdown of the barrier has been shown to result in increase of copper levels in aqueous humour, which is associated with an influx of plasma proteins into the anterior chamber.^{4,10} Thus in one of our patients who had a glaucomatocyclitic crisis (Posner-Schlossman syndrome) we found an aqueous humour zinc concentration of 0.050 $\mu\text{g/ml}$ (0.76 $\mu\text{mol/l}$) and copper concentration of 0.356 $\mu\text{g/ml}$ (5.6 $\mu\text{mol/l}$). It has been reported that during the stress of infection or inflamma-

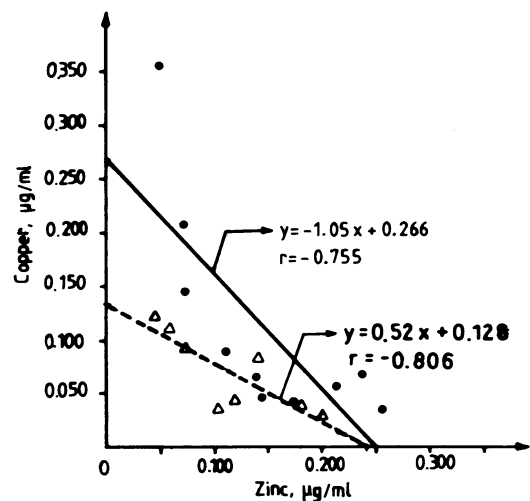


Figure 3 Regression line between aqueous humour zinc and copper concentrations (●: glaucoma, △: glaucoma + cataract).

tion copper levels rise and zinc levels fall owing to the acute-phase reaction.² Moreover there may be slightly increased serum copper levels in all groups for the reasons noted above.

According to our results here a negative correlation between aqueous humour copper and zinc levels in patients with glaucoma, especially when caused by trauma and inflammation, may be of importance. It is concluded that increase in the copper concentration in the aqueous humour may indicate a breakdown of the blood-aqueous barrier. This subject needs further investigation.

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