Levels of zinc in plasma, erythrocytes, and hair, and levels of serum copper in patients with retinitis pigmentosa in Turkey

LEYLA S ATMACA, AYTEN ARCASOY, AYHAN O ÇAVDAR,
AND EMIN ÖZMERT

From the Retinal Diseases/Fluorescein Angiography/Photocoagulation Therapy Department, Eye Clinic, Ankara University

SUMMARY This study was made on 100 patients with retinitis pigmentosa and 23 of their relatives. Their plasma, erythrocyte, and hair Zn and serum Cu levels were compared with those of a control group of 14 healthy persons. No statistically significant difference in these levels was found between the patients with retinitis pigmentosa and the relatives or controls.

For the past 20 years zinc has been a trace element of interest to nutritionists, medical researchers, and clinicians. Zinc has been found to be involved in many eye functions, for example, rod functions and dark adaptation. Normal rod functions and dark adaptation require that rhodopsin be produced from retinol. This in turn requires retinal reductase enzymes which have zinc as the activating constituent.

There are few studies on trace elements in retinitis pigmentosa.¹⁻¹¹ In 1976 Gahlot *et al.*² reported on the relation between copper and zinc metabolism in retinitis pigmentosa. They measured serum copper and ceruloplasmin and 24 hour urine copper levels in retinitis pigmentosa. There are few studies on zinc metabolism in retinitis pigmentosa. In the present study, in addition to the plasma zinc and serum copper levels, we measured the erythrocyte and hair zinc levels.

Material and methods

The study was made on 100 patients with retinitis pigmentosa and their 23 healthy relatives. The results were compared with those from a control group of 14 healthy persons of similar socioeconomic class.

The group of 100 patients with retinitis pigmentosa

comprised 73 men and 27 women, the 23 relatives 18 men and 5 women, and the control group 5 men and 9 women. The age of the patients with retinitis pigmentosa ranged from 11 to 71. The average age was 31 in the retinitis pigmentosa group, 23 in the relatives, and 18 in the controls. A complete history was obtained from all patients with retinitis pigmentosa, and medical and ophthalmological examinations were performed. In the ophthalmological examinations, in addition to routine visual tests, both eyes of all the patients were examined by Goldmann's three-mirror contact lens, Goldmann's kinetic perimetry, fluorescein angiography, and colour fundus photography.

Those who were pregnant, taking birth control medication, on other medication or suffering from any systemic disease which might effect their Cu/Zn metabolism were eliminated

Blood and hair samples were taken from the 137 study participants by one supervised technician. All the samples were taken between 0800 and 0900 following a complete fast of at least 12 hours. The samples were transferred to the Zn Deficiency and Treatment Unit, where they were tested under the control of one of the authors.

The hair samples were investigated by the method suggested by Schroeder and Nason.¹² The 2380 model Perkin Elmer atomic absorption spectrophotometer was used.

The statistical comparisons were made by the Barlett χ^2 test method. Nine additional parameters were analysed statistically.

This study was supported by the Zn Deficiency Treatment Unit established by the Turkish Scientific and Technical Research Council (TUBITAK) in the Paediatric Clinic, Ankara University.

Correspondence to Leyla S Atmaca, MD, Gazi Mustafa Kemal Bulvarı, 23/2, Ankara, Turkey.

Results

No statistically significant difference was found between the average plasma, erythrocyte, and hair zinc and serum copper levels of the patients with retinitis pigmentosa and those of the relatives and controls, nor was sex found to be a significant factor (Table 1).

The duration of the retinitis pigmentosa showed no correlation with the plasma, erythrocyte, and hair zinc and serum copper levels (Table 2).

No statistically significant difference was found between the plasma, erythrocyte, and hair zinc and serum copper levels of 21 patients with retinitis pigmentosa and those of the 23 persons who were their relatives (Table 3).

No statistically significant correlation was found between the average plasma, erythrocyte, and hair zinc and serum copper levels and the visual acuity evaluated in the 192 eyes of 96 patients with retinitis pigmentosa (Table 4).

Visual field defects in patients with retinitis pigmentosa were classified as mild, generalised, or tubular. The type and the quantity of the visual field defects had no correlation with the average plasma, erythrocyte, and hair zinc and serum copper levels (Table 5).

In patients with retinitis pigmentosa having additional fundus changes (such as degeneration of the

Table 1 Zn and Cu levels in retinitis pigmentosa patients, unaffected relatives, and controls, mean (SEM), by sex

	Plasma Zn µg/100 ml (SEM)	Red corpuscle µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
RP patients			
Male	80.85 (1.75) (n: 72)	12.24 (0.25) (n: 72)	111.71 (4.43) (n: 57)
Female	78.64 (3.05) (n: 24)	12.16 (0.34) (n: 26)	116.73 (6.93) (n: 26)
Total	80.35 (1.51) (n: 96)	12.21 (0.20) (n: 98)	113.26 (3.72) (n: 83)
Relatives			
Male	79.44 (3.58) (n: 17)	12.07 (0.45) (n: 17)	111.94 (8.63) (n: 13)
Female	77.0 (4.46) (n: 5)	11.41 (1.03) (n: 5)	131.4 (18.23) (n: 5)
Total	78.20 (2.38) (n: 22)	12.20 (0.42) (n: 22)	109.25 (8.19) (n: 18)
Controls			
Male	83.8 (2.24) (n: 5)	13.82 (0.84) (n: 5)	124.5 (24.05) (n: 4)
Female	77.89 (4.02) (n: 9)	12.4 (0.68) (n: 9)	115.41 (11.50) (n: 8)
Total	80.57 (3.86) (n: 14)	12.90 (0.53) (n: 14)	121.65 (10.28) (n: 12)

RP=retinitis pigmentosa. $p>0.05$ not significant.
SI conversion: ($\mu\text{g} \times 10$)/100 ml= $\mu\text{g/l}$.

Table 2 Zn and Cu values of RP patients by duration of RP, mean (SEM)

Duration (years)	Plasma Zn µg/100 ml (SEM)	Red corpuscle Zn µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
≤5	82.05 (2.62) (n: 20)	11.97 (0.49) (n: 20)	112.77 (6.80) (n: 18)
6–10	79.55 (2.54) (n: 39)	12.23 (0.27) (n: 49)	115.70 (5.55) (n: 33)
11–20	79.47 (3.50) (n: 24)	12.63 (0.46) (n: 25)	110.46 (5.81) (n: 20)
>21	81.76 (3.27) (n: 13)	11.80 (0.64) (n: 13)	112.10 (16.16) (n: 12)

RP=retinitis pigmentosa. $p>0.05$ not significant.
SI conversion: ($\mu\text{g} \times 10$)/100 ml= $\mu\text{g/l}$.

Table 3 Zn and Cu values of RP patients compared with those of unaffected relatives, mean (SEM)

	Plasma Zn µg/100 ml (SEM)	Red corpuscle Zn µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
RP patients	78.64 (3.37) (n: 21)	11.66 (0.41) (n: 22)	126.10 (8.38) (n: 21)
Relatives	78.20 (2.38) (n: 22)	12.20 (0.42) (n: 22)	109.25 (8.19) (n: 18)

RP=retinitis pigmentosa. $p>0.05$ not significant.
SI conversion: ($\mu\text{g} \times 10$)/100 ml= $\mu\text{g/l}$.

Table 4 Zn and Cu values by visual acuity of eyes with RP, mean (SEM)

Visual acuity	Plasma Zn µg/100 ml (SEM)	Red corpuscle Zn µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
Abs-PP	79.47 (2.01) 60 eyes	12.79 (0.27) 58 eyes	113.58 (5.57) 52 eyes
5 cm CF	76.60 (2.16) 46 eyes	12.30 (0.25) 50 eyes	115.95 (5.55) 43 eyes
0.1–0.5	83.37 (1.97) 60 eyes	11.83 (0.25) 61 eyes	108.61 (4.12) 46 eyes
0.6	75.62 (2.04) 24 eyes	12.09 (0.48) 23 eyes	117.39 (5.19) 23 eyes
Total RP eyes	192	196	166

RP=retinitis pigmentosa. CF=counting fingers. Abs-PP=absolute perception and projection. $p>0.05$ not significant.
SI conversion: ($\mu\text{g} \times 10$)/100 ml= $\mu\text{g/l}$.

macula and retinal haemorrhages) Zn and Cu levels showed no statistically significant changes compared with the controls (Table 6). Likewise the anterior segment pathology in patients with retinitis pigmentosa did not influence the above mentioned Zn and Cu levels compared with the controls (Table 7).

Although the average hair Zn level in patients with retinitis pigmentosa was higher than that in the controls, the difference was not statistically significant (Table 8).

Zinc in plasma, erythrocytes, and hair, and serum copper in patients with retinitis pigmentosa

Table 5 Zn and Cu values by reduction in visual field, mean (SEM)

Degree of constriction	Plasma Zn µg/100 ml (SEM)	Red corpuscle Zn µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
Mild	75.07 (2.73) (n: 19)	11.44 (0.44) (n: 22)	116.29 (6.34) (n: 17)
Generalised	85.02 (4.12) (n: 19)	11.64 (0.37) (n: 20)	120.78 (9.75) (n: 14)
Tubular	81.73 (3.13) (n: 17)	12.26 (0.53) (n: 13)	110.30 (8.57) (n: 15)

p>0.05 not significant.

SI conversion: (µg×10)/100 ml=µg/l.

Table 6 RP patients with additional fundus changes compared with healthy controls, mean and (SEM)

	Plasma Zn µg/100 ml (SEM)	Red corpuscle Zn µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
RP patients	75.79 (3.04) (n: 17)	12.24 (0.38) (n: 17)	115.76 (7.67) (n: 16)
Controls	80.57 (3.86) (n: 14)	12.90 (0.53) (n: 14)	121.69 (10.28) (n: 12)

RP=retinitis pigmentosa. p>0.05 not significant.

SI conversion: (µg×10)/100 ml=µg/l.

Table 7 RP patients with anterior segment pathology compared with healthy controls, mean (SEM)

	Plasma Zn µg/100 ml (SEM)	Red corpuscle Zn µg/ml (SEM)	Serum Cu µg/100 ml (SEM)
RP patients	75.58 (1.81) (n: 42)	12.63 (0.32) (n: 41)	112.23 (5.87) (n: 39)
Controls	80.57 (3.86) (n: 14)	12.90 (0.53) (n: 14)	121.69 (10.28) (n: 12)

RP=retinitis pigmentosa. p>0.05 not significant.

SI conversion: (µg×10)/100 ml=µg/l.

Table 8 Hair Zn values in RP patients and healthy controls, mean (SEM)

	Hair Zn (µg/g (SEM)
RP patients	175.63 (7.9) (n: 81)
Healthy controls	146.34 (10.24) (n: 15)

RP=retinitis pigmentosa. p>0.05 not significant.

Discussion

The main purpose of this study was to investigate whether any relation existed between retinitis pigmentosa and zinc metabolism. Previously only the relation of copper metabolism to retinitis pigmentosa had been extensively studied; only a few studies had

been made on the relation between zinc metabolism and retinitis pigmentosa.^{1 9-11}

This study showed no significant change in the average plasma, erythrocyte, and hair zinc levels in retinitis pigmentosa. In addition, the Zn levels showed no correlation with the duration and seriousness of the retinitis pigmentosa. Although we found an obviously low level of Zn in the plasma, erythrocytes, and hair in some patients with retinitis pigmentosa, this low level could not certainly be attributed to the retinitis pigmentosa, since a low level of Zn might have several causes.

Our findings did not confirm the studies of Gahlot *et al.*, who had reported that disorders of copper metabolism were characteristic for retinitis pigmentosa. In 1977 Ehlers and Bülow found a normal Cu metabolism in patients with retinitis pigmentosa.³ This result was confirmed by Marmor *et al.* in 1978.⁴ In 1982 Mota *et al.* also found no change in the Cu metabolism in patients with retinitis pigmentosa.⁵

In 1981 Sangameswar *et al.* found a partial change in the copper metabolism of the patients with retinitis pigmentosa.⁶

We found in comparison with controls that neither serum Cu levels nor Zn metabolism in retinitis pigmentosa showed any significant changes.

References

- Rosenthal AR, Eckhart C. Copper and zinc in ophthalmology. In: Karcioğlu ZA, Sarper RM, eds. *Zinc and copper in medicine*. Springfield: Thomas, 1980: 579-627.
- Gahlot DK, Khosla PK, Makashir PD, Vasuki K, Basu N. Copper metabolism in retinitis pigmentosa. *Br J Ophthalmol* 1976; **60**: 770-4.
- Ehlers N, Bülow N. Clinical copper metabolism parameters in patients with retinitis pigmentosa and other tapetoretinal degenerations. *Br J Ophthalmol* 1977; **61**: 595-6.
- Marmor MF, Nelson JW, Levin A. Copper metabolism in American retinitis pigmentosa patients. *Br J Ophthalmol* 1978; **62**: 168-71.
- Mota MC, Abreu F, Marquis EP. Copper metabolism in retinitis pigmentosa. *Exp Ophthalmol* 1981; **7**: 21-9.
- Sangameswar SR, Satapathy M, Sitaramayya A. Copper metabolism in retinitis pigmentosa patients. *Br J Ophthalmol* 1981; **65**: 127-30.
- Bastak J, Bodger J, Cinotti A, *et al.* Trace metals in a family with sex-linked retinitis pigmentosa. *Adv Exp Med Biol* 1977; **77**: 43-50.
- Crouch RK, Chambers JK. Absence of abnormal erythrocyte superoxide dismutase, copper, or zinc levels in patients with retinitis pigmentosa. *Br J Ophthalmol* 1982; **66**: 417-21.
- Karcioğlu ZA, Stout R, Hahn H. Serum zinc levels in retinitis pigmentosa. *Curr Eye Res* 1984; **3**: 1043-8.
- Kubalska J, Sliwinska J, Skubaszewska P, Krajewska-Walasek M, Pietraszek E, Pronicka E. Changes in copper and zinc levels in the serum erythrocytes and urine of patients with retinitis pigmentosa. *Pediatr Pol* 1984; **55**: 209-16.
- Silverstone DZ, Berson D, Seelenfreund MH. Plasma zinc levels in high myopia and retinitis pigmentosa. *Metab Ophthalmol* 1981; **5**: 187-90.
- Schroeder HA, Nason PA. Trace metals in human hair. *J Invest Dermatol* 1969; **53**: 71-8.

Accepted for publication 1 October 1987.