AN APPLICATION OF PIXE-MICROPROBE IN THE STUDY OF GALACTOSEMIC CATARACT

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ABSTRACT

The spatial distribution of minor elements in the lenses from animals of galactosemic cataract was measured by PIXE-microprobe. Tremendous increase of Cl and Ca level with decrease of K level was observed in a lyophilized opaque lens from a young guinea-pig using a 200 μm 28 MeV α-particle beam. Further systematic studies with a 2 MeV proton microprobe, 50 μm in diameter, suggest strong correlation of the ion level in hydrated lenses to the mechanism of the onset of galactosemic cataract.

For almost a decade, the particle induced X-ray emission (PIXE) has been well utilized for element analysis with high sensitivity . Recent interest in developing PIXE-microprobe is prompted by its unique capability of measuring spatial distributions of elements, non-destructively, in hydrated or even live samples with high sensitivity (1).

For the PIXE analysis of biological samples, we have made a stable 200 μm beam spot of 28 MeV α-particles from IMS cyclotron, using standard quadrupole doublets. This small beam was utilized for the element analysis of the lenses from guinea-pigs of galactosemic cataract (2).

Galactosemic cataract is an important experimental animal model of a human cataract induced by diabetes. By feeding a galactose rich diet to young animals, the nuclear opacity appears quite suddenly a few weeks later.

The distribution of S, Cl, K and Ca in the sagittal plane of a lyophilized lens was measured. Elemental distributions along the optical axis are compared in Fig.1. for clear and opaque lenses from galactose-fed guinea pigs. Any noticeable difference was not found in clear lenses from normal and galactose-fed animals. Increase of Cl and Ca with decrease of K is seen in an opaque lens in Fig.1. Two-dimentional analysis showed that Cl and K are abundantly located along the equator of the lenses.

Following such observations, systematic study was continued using young rats. The 2 MeV proton beams from MIT-Lincoln Laboratory were used. The beam was collimated to 50 μm in diameter through a pinhole. We have noticed that the lens of a young rat is hydrated tissue and the elemental concentration per wet tissue is the important factor in understanding the mechanism of catact. So, we have tried analysing frozen lenses.

In Fig.2, the elemental distribution in the sagittal plane of an opaque lens, in a very early stage of nuclear cataract, is compared with a normal lens. Darkness indicates high abundance of the element. Whole the eyes are shown in the picture.

The distribution of S, an indicator of the lens protein, shows an influx of water from the periphery of the opaque lens. Increase in Cl level and decrease in K level are also found. These results support the mechanism for the onset of nuclear cataract that the opacity is caused as a result of a phase

separation of protein - salt water mixture of the cytoplasm of the lens (3). The quantitative effect of the ion level on the elevation of the phase separation temperature needs further study. More detailed description will be found elsewhere.

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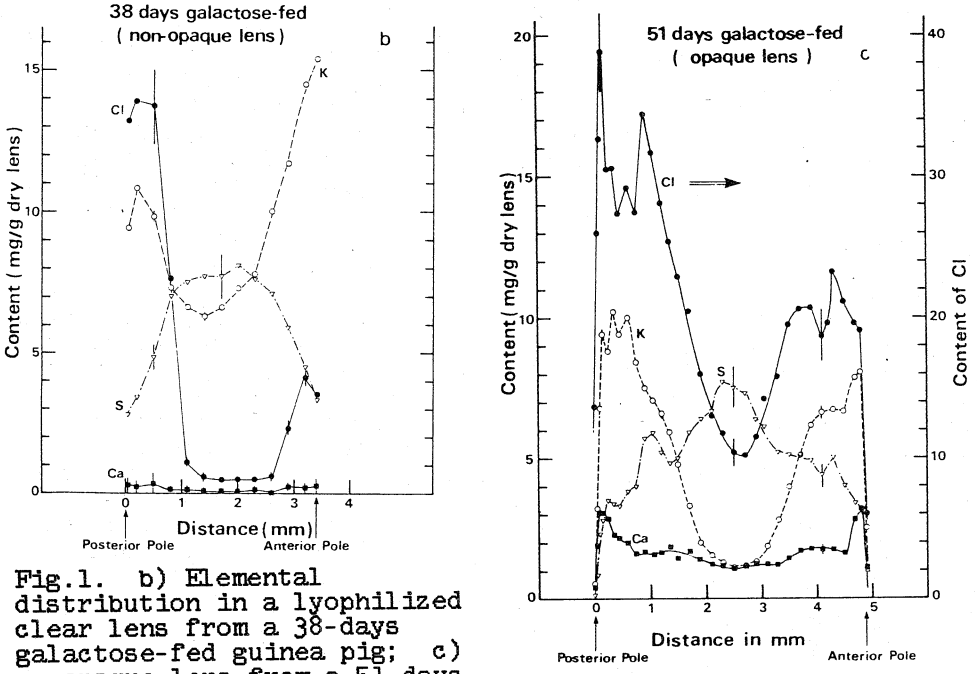

Fig.1. b) Elemental distribution in a lyophilized clear lens from a 38-days galactose-fed guinea pig; c) an opaque lens from a 51-days galactose-fed guinea pig.

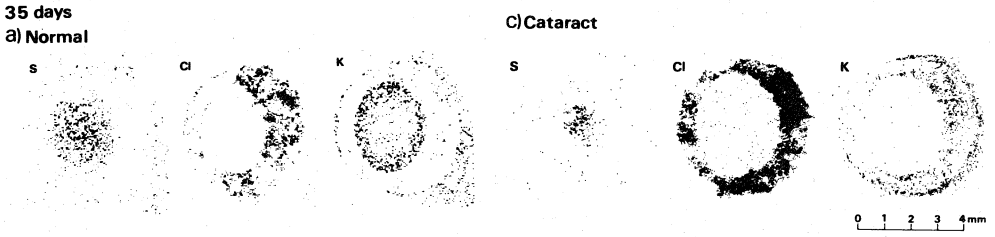

Fig.2. Elemental distributions in frozen lenses from 35 days old rats, fed on a normal diet (a), and on a galactose diet for 14 days (opaque) (c). In the picture, hemisected eyes facing to the left are shown.

References

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