AN APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO BIOLOGICAL MATERIALS

IV. APPROACH TO SIMULTANEOUS DETERMINATION OF TRACE ELEMENTS IN HUMAN EYE TISSUES WITH NON-DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS

T. YAMAGUCHI,* M. BANDO,* A. NAKAJIMA,* M. TERAI,** M. SUZUKI-YASUMOTO***

*Department of Ophthalmology, Juntendo University School of Medicine, Bunkyo-ku, Tokyo 113 (Japan)

**Department of Chemistry, Faculty of Science, Tokyo Metropolitan University, Setagaya-ku, Tokyo 158 (Japan)

***Division of Environmental Hygiene, National Institute of Radiological Sciences, Chiba-shi, Chiba 280 (Japan)

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Fourteen trace elements (short-lived nuclides: Al, Br, Cu, Mn and V; long-lived nuclides: Ag, Au, Cd, Co, Cr, Fe, Sc, Se and Zn) in human eye tissues are determined simultaneously by non-destructive neutron activation analysis. The quantity of Al, Br, Fe, Se and Zn in the eye tissues (about 1 to more than 10 μg/g dry weight tissue) seems to be higher than that of other trace elements, although content of each trace element in individual tissue are scattered in a wide range. Conjunctiva, iris (+ciliary body) and choroid (+pigment epithelium) seem to contain larger amount of various trace elements than other eye tissues. From correlation studies it is evident that the relative distribution of 14 trace elements in various eye tissues are similar, and furthermore the content of trace elements in the eye tissues may be correlated in each of the three groups (group A: Cd, Fe, Se and Zn; group B: Al, Cr, Fe, Se and V; group C: Al, Au, Fe and Se).

Introduction

With increased pollution of our environment, attention is directed recently to actions or effect of various trace elements in tissues. Some of trace elements in eye tissues, mainly Cu, Mn and Zn, have been determined by atomic absorption analysis, colorimetric method, electrochemical method or X-ray fluorescence analysis. However, these methods are not suitable for simultaneous analysis of many trace elements. In our preliminary report, it has been shown that detection and determination of 5 trace elements (short-lived nuclides: Al, Br, Cu, Mn and V) in small amounts of human eye tissues can be carried out simultane-
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ously by non-destructive neutron activation analysis. RÁCZ and ÖRDÖGH \(^{15}\) have also analyzed 7 trace elements (Co, Cu, Mn, Ni, Rb, Sc and Zn) in human lens with neutron activation method after a chemical separation of the trace elements, and LAKOMAA and EKLUND \(^{16}\) have determined Fe, Rb, Se and Zn in cataractous human lens by the activation analysis under non-destruction of samples.

The report presents the determination of the distribution of 14 trace elements (short-lived nuclides: Al, Br, Cu, Mn and V; long-lived nuclides: Ag, Au, Cd, Co, Cr, Fe, Sc, Se and Zn) in human eye tissues by non-destructive activation analysis, and to examine the correlation between the tissues or the elements in respect to distribution of the elements in the eye tissues.

Experimental

Five normal human eyes, in ice-cold preservation medium, \(^{17}\) enucleated within 6 hrs postmortem, were obtained from Juntendo Eye Bank. The ages were from 42 to 77 years old. Metal and halogen ions contained in the medium are only Na, Cl, K, Ca and Mg (more than 20 \(\mu\)g/ml to about 4 mg/ml), and a small amount of Fe (about 0.02 \(\mu\)g/ml). Each eye taken out from the medium was dissected to various parts with stainless steel instruments within 1 hr after its enucleation. Individual tissues obtained were immediately weighed, and the weight was considered as the wet one. The tissues were then dried in vacuum until constant weight, and the dry weight was measured. Determination of trace elements (Ag, Al, Au, Br, Cd, Co, Cr, Cu, Fe, Mn, Sc, Se, V and Zn) in human eye tissues was carried out by the neutron activation analysis, as described previously \(^{14}\) and as described additionally in the following. As standards, \(\text{NH}_4\text{VO}_3\), \(\text{H}_2\text{SeO}_3\), Ag, Al, Au, Cd, Co, Cr, Cu, Fe, Mn, Sc and Zn with higher purities than 99.9\% were separately dissolved in water or in diluted acid (\(\text{HNO}_3\), \(\text{H}_2\text{SO}_4\) or aqua regia) at concentrations of 0.1 to 1 mg/ml. 10 \(\mu\)l of the solution was then filtered by a filter paper (2 \(\times\) 2 cm\(^2\)), and the paper was air-dried. The filter papers were used as standards. KBr was powdered for use as standard. Standards and samples were irradiated in the rotary specimen rack of Rikkyo University TRIGA MARK II Reactor operating with a thermal neutron flux of \(5 \cdot 10^{11} \text{n} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}\). Radioactive forms of the above trace elements measured were short-lived nuclides; \(^{28}\text{Al}\), \(^{80}\text{Br}\), \(^{66}\text{Cu}\), \(^{56}\text{Mn}\) and \(^{52}\text{V}\), and long-lived nuclides; \(^{110m}\text{Ag}\), \(^{198}\text{Au}\), \(^{115}\text{Cd}\), \(^{60}\text{Co}\), \(^{51}\text{Cr}\), \(^{59}\text{Fe}\), \(^{46}\text{Sc}\), \(^{75}\text{Se}\) and \(^{65}\text{Zn}\). After a short irradiation for 3 min and cooling for 3 min, gamma-ray spectra from short-lived nuclides were measured by Camberra multichannel pulse height analyzer Type 8100 with Ge(Li) detector (Camberra Industries Inc., USA). The gamma-ray spectra from long-lived nuclides were measured.