Preliminary studies of elemental spatial redistribution in breast tumors

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INTRODUCTION

Synchrotron radiation combined with capillary optics has been used as an optimal x-ray source for microanalysis. It can be used to excite x-ray fluorescence and this approach leads to very low detection limits on micrometric areas on very small samples. Synchrotron microscopic XRF (μ-SRXRF) allows quantitative study of the nature and degree of heterogeneity of inorganic constituents in biological samples. This microbeam method, due to intrinsic characteristics of SR, is able to implement multielemental spectrochemical analysis with spatial resolution on the micrometer scale. It shows high efficiency for element determination and short time of analysis requirements. In the present work, we applied μ-SRXRF to study spatial distribution of elements on normal and cancerous human breast tissue in order to identify possible correlations induced by the desease.

Several authors have shown that there is a significant increase of Ca, Cr, Mn, Fe, Cu, Zn and Br in breast tumors compared to normal tissues [1–3]. Since until now the research were mainly going to macroscopic level, it is interesting to study the spatial distribution of these elements to extend the knowledge to the microscopic scale. In these studies spatial redistribution of trace elements due to biochemical changes in tumors may be observed.

EXPERIMENT

We employed the SR-μXRF technique in the D09B beamline of the National Synchrotron Light Laboratory in Campinas, Brazil to determine the distribution of P, S, K, Ca, Fe, Ni, Zn, Cu in human breast tissue. The samples were extracted by biopsies in a private clinic of the Córdoba Province and maintained in aqueous solution of formaldehyde at 5% until few minutes before the measurements. Three normal and five cancerous tissues were analized. The excitation beam was focalized by using a capillary lens allowing a spatial resolution of 30 μm. The samples were positioned in a sample holder with an accuracy of 0.5 μm and a 3 axis (x, y, z) remote-controller stage. The counting live-time for each pixel was 100 s/step and the step size was 30 μm/step in both directions.

RESULTS AND DISCUSSION

Figure 1 shows the profiles of the XRF intensity for the analyzed elements recorded in a linear scan on a normal breast tissue. They were grouped in majority elements (part a) and minority elements (part b). The iron profile was included as a red curve in both groups to highlight its behavior. The profiles for an equivalent scan but on a cancerous breast tissue is shown in Figure 2. The comparison of the results shows that in the cancerous tissue iron loses correlation with majority elements while increases correlation with minority elements. We observed systematically the same behavior on all analyzed tissues which indicates that there is a redistribution of the iron caused by the desease.

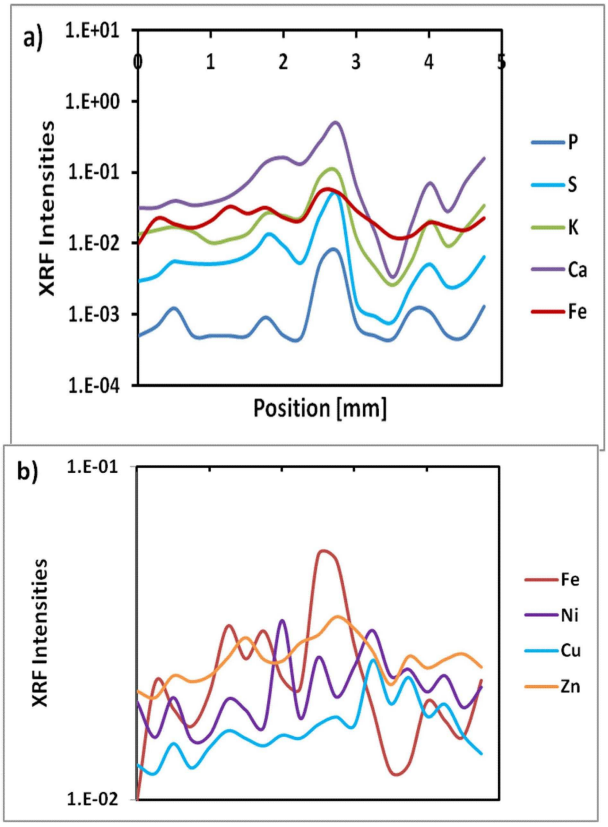

FIG. 1: Profiles of the XRF intensity for the analyzed elements recorded in a linear scan on a normal breast tissue. a) Majority elements b) Minority elements.

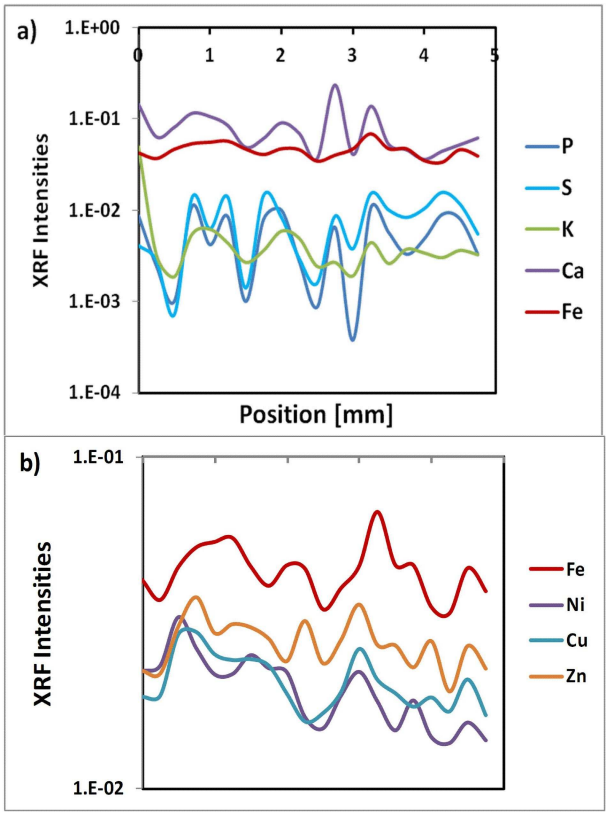

FIG. 2: Profiles of the XRF intensity for the analyzed elements recorded in a linear scan on a breast tumor. a) Majority elements b) Minority elements.

CONCLUSION

Preliminary studies indicate that there is spatial redistribution of trace elements in cancerous breast tissues mainly observed for iron. Further research we are going to interpret this redistribution in the framework of a biological model of breast tumors.

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