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Human Hair as a Possible Diagnostic Tissue for Breast Cancer: Correlation between Ca Accumulation in Hair Medulla and Cancer Status Estimated by Pathological Data

Masaya TORIGATA[1], Atsushi ITO[1,*], Hironobu AMANO[1], Kenta URANO[1], Shigeo YOSHIDA[1]
Kozue YOKOYAMA[2], Risa OSHITANAI[2], Naoki NIIKURA[2] and Yutaka TOKUDA[2]
[1]School of Engineering, Tokai Univ., Hiratsuka, Kanagawa 259-1292, Japan
[2]School of Medicine, Tokai Univ., Isehara, Kanagawa 259-1193, Japan

1 Introduction

Human hair is known to preserve time-dependent information about blood contents ranging from hair root to hair tip, because it grows about 1cm per month by gaining nutrition through the contact with blood only at the root site. Measurement of positon-dependent Ca content in human hair was proposed for the very early detection of breast cancer [1]. Although many factors affect Ca content in hair, we reported that Ca accumulation in cuticle, surface of hair, was mainly caused by external oxidative damage, while Ca content in medulla, a central part of hair, would reflect Ca content in blood [2]. In addition, we have observed significant Ca accumulation in medulla at certain positions from hair root preferentially for hair specimen from breast cancer patients [3]. In order to correlate the position showing inreased Ca accumulation in medulla and the state of cancer growth, we intended to compare the position of increased Ca content in medulla, and pathological data on the breast cancer growth.

2 Materials and Methods

Hair specimens were kindly supplied from women suffered from breast cancer with informed consent at Tokai University Hospital with pathological information about cancer size and Ki-67 value as an index of cancer growth rate. Prior to the measurements at Photon Factory, local Ca content in hair was measured from hair root to hair tip by using X-ray analytical microscope (XGT-2700, HORIBA, Ltd., Japan) with X-ray microbeam of 100 μm diameter. Several positons including the position with maximal Ca content were determined, cut with a thickness of about 20 μm, and attached on SiN membrane as described previously [2]. X-ray contact microscopy was used for imaging Ca distribution using the Ca-K absorption edge at BL-11B with a spatial resolution of about 0.5 μm, and for the imaging of oxidative damage evaluated by cysteic acid content using the S-K absorption edge. Ca mapping of high sensitivity was also performed by detecting X-ray fluorescence (XRF) upon X-ray microbeam exposure with a diameter of around 5 μm at BL-4A.

3 Results and Discussion

We compared hair samples of the same cancer size with different Ki-67 (Fig. 1). Panel (a) plots Ca content in medulla normalized by the thickness of cross-sectional sample. Both samples, #1 and #2, have the cancer size of 14mm. Sample #1 and #2 has Ki-67 of 15% and 20%, respectively. The position with increased Ca content tends to locate closer to the hair root. This result may be interpreted as follows: Assuming that Ca increase in medulla is the premonitory symptom of breast cancer, in the case of more rapidly growing cancer with larger Ki-67, the period between the time of cancer detection corresponding to the position of hair root and the time of Ca increase would become shorter. Panel (b) shows Ca maps obtained at BL-4A at the hair positions of increased Ca as indicated by red circles. Ca was accumulated in medulla in both cases, but for the sample #2, in addition to medulla the accumulation of Ca in cuticle was observed, which probably results from artificial oxidation by bleach or perm treatment. The above interpretation should be confirmed by the accumulation of measurements of hair specimens from breast cancer patients in various cancer stages.

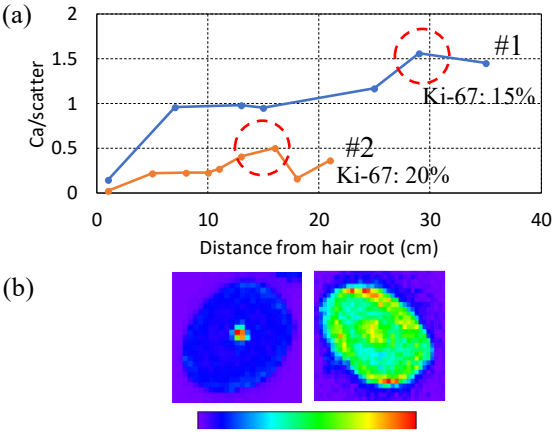

Fig. 1: Comparison of medulla Ca content in hair samples from patients with the same cancer size.
(a) Ca profile from hair root to tip. Scatter is used as an index of sample thickness. Red circles indicate the increased position of medulla Ca content. Cancer size is 14mm, and Ki-67 value is indicated in the graph.
(b) XRF maps of Ca in the cross-section of hair samples.

References

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* aeito@keyaki.cc.u-tokai.ac.jp