

Ca Accumulation in Hair Medulla as a Possible Early Diagnosis of Breast Cancer: Characteristics of Ca Content in Hair Specimens from Breast Cancer Patients in Advanced Stages

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1 Introduction

Human hair is known to provide time-dependent blood information including elemental content 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 site of hair root. The application of the position-dependent Ca variation to the very early detection of breast cancer was proposed by Chikawa et al. [1]. Although many factors affect Ca content in hair, we found that Ca accumulation in cuticle, surface of hair, and the major part of cortex, inner part of hair, was mainly caused by external oxidative damage, while Ca content in medulla, a central part of hair, is likely to result from Ca content in blood [2]. Continuing effort to derive the relation between medulla Ca content from hair root to hair tip and the incidence of breast cancer has been done using hairs from breast cancer patients with various stages of cancer progression. In our report last year, we found that the Ca peak in hairs from cancer patients in the early stage tends to situate near the hair root compared with hairs from cancer patients in other cancer stages [3]. In the present study, we report the characteristics of peak positions of medulla Ca content in hairs from patients with malignant breast cancer.

2 Materials and Methods

Hair specimens were kindly supplied from women suffered from breast cancer with informed consent at Tokai University. We selected hair specimens from patients with high Ki-67 value, or HER2+ (positive), or early onset in her twenties to thirties. Ki-67 is an index of cancer growth activity. HER2 is a protein called human epidermal growth factor receptor 2, and HER2 positive breast cancer has high growth rate and aggressive nature. We also adopt breast cancer that onsets as early as in the 20s to 30s, because juvenile cancer is supposed to be malignant. For comparison, we measured hairs from normal, healthy women. Prior to the measurements at Photon Factory, local Ca content in hair was measured every 1 cm 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 positions including the position with maximal Ca content were selected, cut with a thickness of about 20 μm , and attached on SiN membrane as described previously [2]. X-ray contact microscopy installed at BL-11B was used for Ca imaging at the Ca-K absorption edge with high spatial resolution, and for the imaging of

oxidative damage area evaluated by cysteic acid content at the S-K absorption edge. Fluorescent Ca mapping with high sensitivity was performed using X-ray microbeam with a diameter of approximately 5 μm at BL-4A.

Medulla Ca content was evaluated by normalizing medulla Ca content by Ca content in cortex, major part of hair.

3 Results and Discussion

Figure 1 shows medulla Ca content as a function of the distance from hair root for three kinds of malignant breast cancer measured at BL-4A. Compared with normal samples, it is easily observed that 1) the variation of Ca content is significantly large with several peaks, and 2) Ca level seems to be generally high. The large variation may reflect complex Ca metabolism during cancer progression. The relation between peak positions and cancer progression is a future issue by comparing samples from malignant cancer with various sizes.

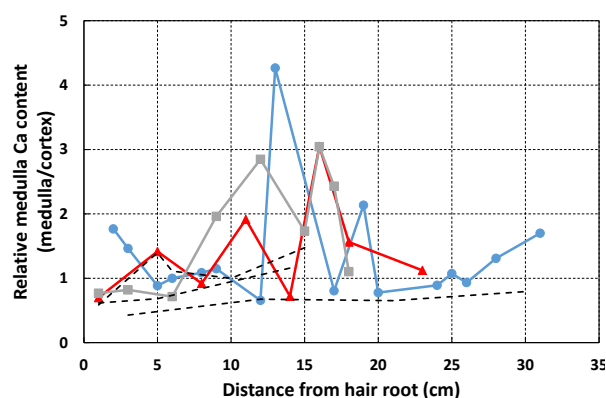


Fig. 1: Comparison of medulla Ca content in hair samples from malignant breast cancer patients.

Red line: HER2+ and high Ki-67; Gray line: high Ki-67; Blue line: juvenile. Broken lines show samples from normal and healthy women.

References

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