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Ca accumulation in hair medulla as a possible early diagnosis of breast cancer: X-ray imaging of hair specimens from early breast cancer patients

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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. Measurement of position-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, 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]. Based on these preceding studies, we measured the peak positions of Ca content in the total length of female hair from hair root to hair tip, using hairs from patients in various stages of breast cancer. In the previous reports, we showed that the peak position tends to shift to the hair root side for the patients with larger Ki-67 value, an index of cancer growth activity, by comparing two groups with similar cancer size and different Ki-67 level [3]. In the present study, to confirm this correlation, we examined the position of Ca peak distinctive to early breast patients.

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 non-invasive very early-stage breast cancer, diagnosed as ductal carcinoma in situ (dcis) For comparison, we also used hairs from patients in other stages of breast cancer. 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 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.

To correct the contribution of Ca content due to oxidative damage, medulla Ca content was divided by cortex Ca content, major of which was supposed to result from Ca accumulation by oxidative damage.

3 Results and Discussion

Figure 1 shows medulla Ca content as a function of the distance from hair root for the dcis case (solid lines) and for the advanced stages of cancer progression (broken lines). In the specimens from the early stage of breast cancer, Ca peak was observed near the hair root within 10cm in the present case. On the other hand, hairs from the advanced stages had Ca peaks more distant from the root than the case of the early stage. In addition, in some cases multiple peaks were observed. These results are in accord with our hypothesis that the position of Ca peak may reflect the time of cancer incidence, although it is not clear whether Ca imbalance in blood is the cause or result of cancer incidence. Since we have only two samples for early stage breast cancer, the above interpretation should be further checked by the accumulation of measurements of hair specimens in the similar cancer stage.

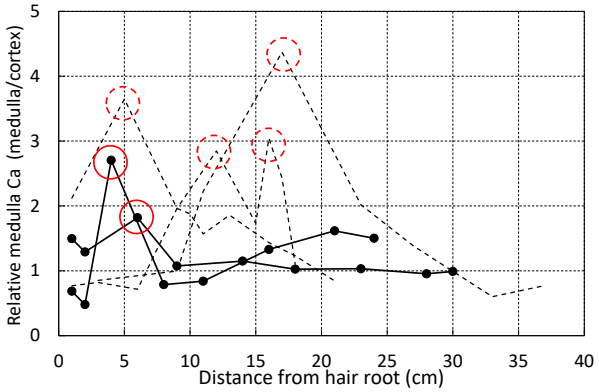

Fig. 1: Comparison of medulla Ca content in hair samples from breast cancer patients in the early stage and advanced stages.

Two solid lines: early stage; three broken lines: advanced stages. Red circles indicate the peak positions of medulla Ca content.

References

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