BL-11B, BL-4A/2014G709

Screening Procedure for Imaging of Ca Content and Oxidative Damage at the Local Areas from Root to Tip in Human Hair

Atsushi Ito[1,] *, Kento Nakazato[1], Fumihisa Ouchi[1], Tatsuyoshi Nakane[1], Kunio Shinohara[1], Risa Oshitanai[2], 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

Several studies reported that calcium content in human hair is largely affected by external oxidative damage of bleach or perm treatment [1], while a possible application to medical diagnosis such as forecasting human breast cancer was suggested [2]. In order to discriminate Ca accumulation by external stimuli from that supplied by blood flow around hair matrix cells at the hair root, we have applied X-ray contact microscopy system to the imaging Ca content and oxidative damage, and found that Ca increased by oxidative damage mainly distributes in outer region called cuticle and cortex, in contrast to Ca distribution in medulla, a central part of hair, where Ca seems to be independent of oxidative damage [3]. This observation suggests that Ca content in medulla may be critical for the medical purpose. In the present study, we developed a screening strategy for the imaging of Ca content and oxidative damage from the root to the tip in human hair by combining several X-ray analytical and imaging techniques.

2 Materials and Methods

First, to survey Ca content from the root to the tip in human whole hair, fluorescence X-ray analysis with an X-ray microprobe is used to detect local elemental contents. Laboratory type X-ray analytical microscope (XGT-2700, HORIBA, Ltd., Japan) is employed with 100 μmϕ X-ray microbeam, which just covers the hair thickness. Every 1cm from the root to the hip, the local Ca content is measured. In this way the abrupt increase or decrease in Ca content can be detected. After the identification of the positions with abnormal Ca content, those local areas are cut with a sample slicer (HS-1, Jasco Engineering, Japan) with about 20 μm thickness. The sectioned specimens are then placed on a SiN membrane of 100 nm thickness. For a specimen compatible with X-ray contact microscope, the opposite side of the membrane is coated with Au as a photocathode of an electronic zooming tube, a detector of X-ray contact microscope. The specimens on a SiN membrane are used for the following two imaging techniques: 1) X-ray contact microscopy with a spatial resolution of 0.5 μm for the imaging of oxidative damage of sulfur compound at the S-K absorption edge, and Ca at the Ca-K absorption edge at BL-11B, and 2) scanning X-ray fluorescence imaging with about 5 μm X-ray microprobe for the highly sensitive imaging of Ca at BL-4A.

Specimens of human hair from patients suffering from breast cancer and from normal female are collected with informed consent at Tokai University Hospital.

3 Results and Discussion

Figure 1 shows Ca content dependent on the distance from the hair root to the hair tip. The trend of increasing Ca content with increasing distance from the root was observed, which probably resulted from oxidative damage observed with X-ray contact microscopy (images not shown). At several distances where the change of Ca content seems to be irregular, the cross-sectional distribution of Ca was measured with X-ray contact microscope and X-ray fluorescence imaging. The rapid increase at the 15 cm from the root is probably due to the Ca increase in the medulla and the cuticle as seen from the Ca image. Accumulation of data and the comparison with normal specimens are in progress.

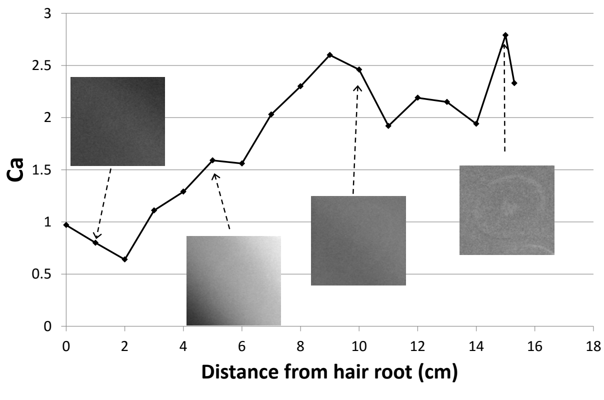

Fig. 1. Dependence of Ca content and distribution on the distance from the root in human hair. Ca content was measured with X-ray analytical microscope. Inserted images were Ca distributions obtained with X-ray contact microscope.

References
[1] K. E. Stmart et al., J. Cosmet. Sci, **60**, 337 (2009).
[2] J. Chikawa et al., J. X-ray Sci. Tech., **15**, 109 (2007).
[3] A. Ito et al., AIP Conf. Proc., **1696**, 020021 (2016).

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