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Imaging Study on Acupuncture points

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Abstract. The topographic structures of acupuncture points were investigated by using the synchrotron radiation based Dark Field Image (DFI) method. Four following acupuncture points were studied: Sanyinjiao, Neiguan, Zusanli and Tianshu. We have found that at acupuncture point regions there exists the accumulation of micro-vessels. The images taken in the surrounding tissue out of the acupuncture points do not show such kind of structure. It is the first time to reveal directly the specific structure of acupuncture points by X-ray imaging.

1. Introduction

When people talk about Chinese medicine, the meridians and acupuncture [1-2] must be mentioned. They have unique effects on illness. To acupuncture some special points on human body, which are called acupuncture point (abbr. as acupoint) and distribute along meridians, can cure many kinds of disease or reduce pains. Unfortunately, until now no one can give a scientific explanation about how the acupuncture takes part in the process of treatment. Something is interesting, but strange. To make clear the mechanism of the acupuncture, many researchers devoted themselves to study in this field using various modern techniques. Some valuable results have been found. For example, two infrared emission bands on the surface of acupoints were observed [3]. The gather of element Ca in acupoints was found by the X-ray fluorescence technique [4]. Therefore, the acupoints are also called Ca pools. However, despite considerable efforts for probing the anatomy of acupoints, the characterization of structures of acupoints remains elusive. In this work one kind of X-ray imaging technique, which has demonstrated enhanced image contrast for dense, highly absorbing materials was used to explore the structural character of acupoints.

2. Experimental and Samples

In order to find out whether there are some differences between acupoint regions and surrounding tissues out of the acupoint, then to identify the radiographic structure of the acupoints, the X-ray Dark Field Imaging method (DFI) [5] based on synchrotron radiation was used to provide detail images of acupoints. DFI is a kind of refraction based imaging [6-7]. When X-ray travels in a sample, the index of refraction n should be complex form. It can be written as

$$n = 1 - \delta - i\beta ,$$

where, β describes the absorption term of X-ray, δ is the phase shift term caused by the refraction effect. The phase shift term can be up to 10^3 times greater than the absorption term for light elements. Therefore, one may observe the phase contrast when the absorption contrast is undetectable.

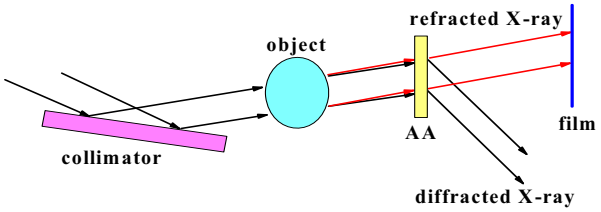

Figure 1. The sketch of the DFI setup at Photon Factory.

The DFI belongs to this kind of imaging technique, which can pick up the different phase information of the sample while suppressing the illumination light and the absorbed X-ray if any. The optics setup of DFI is shown in figure 1. A parallel incident beam emerges from a collimator. The sample is placed between a collimator and an analyzer (AA). When the beam transmitting the sample hits onto the analyzer, it is divided into two parts. One component transmits forward and does not change its direction. It will be diffracted by analyzer (shown with black lines in figure 1). Other component (indicated with red lines) will be refracted inside the sample due to the tiny refractive index variations and pass through the analyzer along original direction. So this analyzer just works as an angular filter. It removes the forward beam and at the same time keeps the refracted beam. Then, the phase information contained in the refracted beam is recorded in an imaging device, such as a film.

Rabbits are taken as the animal model and applied to do DFI experiments. The rabbit is a mammal and has acupoints too [8-9]. The names of rabbit acupoints are as same as in human being.

Table 1. The locations of the samples used for DFI experiment on rabbit's body.

Acupoint	Location on human (rabbit) body
Tianshu	Left and right side of the navel symmetrically on the belly, 2 Cun away from the navel
Neiguan	Lower side of the forearm, 2 Cun above the wrist
Zusanli	Lower part of the crus fibula, 3 Cun under the knee
Sanyinjiao	3 Cun above the ankle

According to the Chinese medicine, the proportional unit of the body, called "Cun" is used to locate the position of acupoint on human being. This method is also applied to rabbit body. The effective diameter of acupoints of rabbit is about 5mm. All samples were cut large enough to contain acupoints. We collected four acupoint samples from rabbit body and named these samples using corresponding names of acupoints. They are Tianshu, Neiguan, Zusanli and Sanyinjiao. Locations of these acupoints are shown in table 1. A pin was used to mark these acupoints positions approximately.

3. Results and discussion

The DFI experiment was performed at the endstation of BL14B in Photon Factory, KEK, where the synchrotron radiation was produced by a 5 Tesla wiggler. The photon energy is 36 keV. In our case, the beam size is approximately 19.7 mm (H)×33.5 mm (W). A Laue-case Si crystal was used as an analyzer, whose diffraction plane was (440) and thickness was about 1mm. The images were recorded on mammographic film of Kodak MinR 2000. The exposure time for each image was 2 minutes.

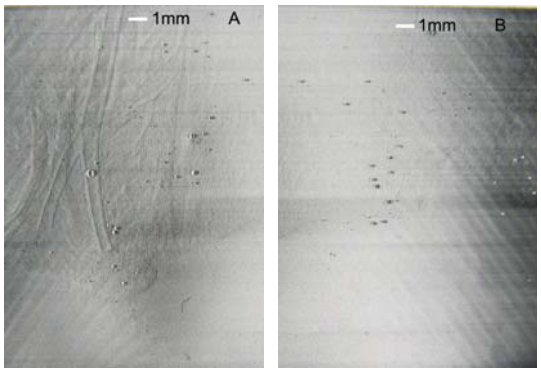

Figure 2. DFI images at Sanyinjiao acupoint region (A) and surrounding tissues (B).

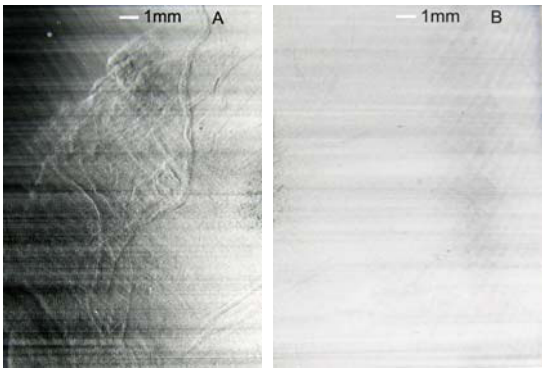

Figure 3. DFI images at Tianshu acupoint region (A) and surrounding tissues (B).

We took photos from the regions of acupoints and surrounding tissues far away from the acpoints. Figure 2 (A) is a photo taken at Sanyinjiao acupoint. A long blood vessel around with some fine branches is displayed clearly. Figure 3 (A) is a picture of Tianshu acupoint, where a short cluster of vessels can be seen. The micro-vessels gathering can also be observed at Neiguan and Zusanli acupoint regions. In the regions out of acupoints there are no such micro-vessels accumulations.

4. Conclusions

The synchrotron radiation based Dark Field Image method was used to study the topographic structures of acupoints. From pictures of four acupoints (Sanyinjiao, Tianshu, Neiguan and Zusanli) we have found that there exists the accumulation of micro-vessels, but in the surrounding tissues out of the acupoints one can not find such kind of structure. Therefore, the micro-vessels gathering are special structures of the acupoints. We suppose that these structures have certain relationship with the function of acupoints and play an important role in acupuncture.

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