BL-14C, AR-NE7A/2014G729

A newly developed technique of synchrotron radiation coronary micro-angiography in an in-vivo rat

Hiroaki Sakamoto[1*], Shonosuke Matsushita[2], Kazuyuki Hyodo[3], Chiho Tokunaga[1], Fujio Sato[1] and Yuji Hiramatsu[1]

[1] Department of Cardiovascular Surgery, Faculty of Medicine, University of Tsukuba, Tsukuba 305-8575, Japan

[2] Faculty of Health Science, Tsukuba University of Technology, Tsukuba 305-8521, Japan

[3] Photon Factory, Tsukuba 305-0801, Japan

1 Introduction

Clinical X-ray angiography system cannot provide images of coronary arteries smaller than 300 μm in diameter. On the other hand, proliferation of collateral arteries in ischemic heart disease and of new blood vessels in regenerative medicine occurs at smaller arteriole sizes. Previously, in our laboratory, synchrotron radiation applied in coronary microangiography using Langendorff-perfused rat hearts could visualize a coronary artery of 50 μm in diameter [1]. However, in vivo rat synchrotron radiation coronary microangiography (SRCA) poses the problem of compromised temporal resolution due to the rapid heart rate of rats. The purpose of this study was to establish a simple method of in vivo rat SRCA with bradycardia induced by intravenous injection of adenosine triphosphate disodium hydrate (ATP).

2 Experiment

SRCA was performed at the Photon Factory of the High Energy Accelerator Research Organization (Tsukuba, Japan). Synchrotron radiation consists of a wide range of wavelengths emitted by charged particles with speeds close to that of light when their orbits are bent by a magnetic field. Synchrotron radiation was obtained from a 6.5-GeV electron beam and converted to 33.3-keV monochromatic X-rays by 13-degree reflection from a silicon crystal. Images were taken using a 2-dimensional recording system consisting of a high-sensitivity CCD camera. This SRCA system has the high resolution of 9 μm per pixel, and its visual field is 36 mm x 24 mm. The high temporal resolution allows the setting of arbitrary SRCA exposure times, and the high-density resolution can differentiate slight variations in density. The exposure time used in this study was 30 milliseconds, and the maximum acquisition rate was 3 images per second.

Wistar rats were anesthetized. The micro polyethylene catheter for angiography was inserted into the carotid artery. SRPA was performed after 5 mg of ATP was given intravenously.

3 Results and Discussion

Fig. 1 shows an image obtained in a preliminary experiment, which consisted of in vivo rat SRCA performed without bradycardia induction. The image is unclear owing to the movement caused by the rapid heart rate. As a countermeasure, we induced temporary bradycardia with ATP. This simple technique involves just lowering the heart rate and maintaining bradycardia for a few minutes. As a result, we could detect a coronary artery as small as 54 μm in diameter (Fig. 2).

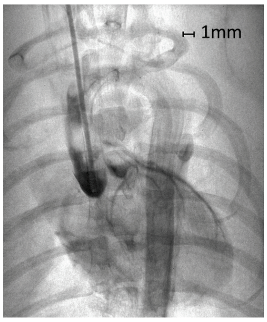

Fig. 1: In vivo rat SRCA obtained in a preliminary experiment

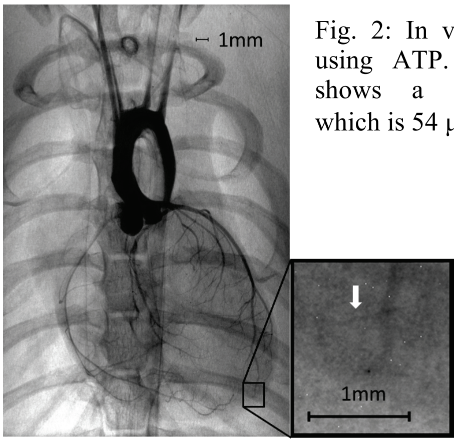

Fig. 2: In vivo rat SRCA using ATP. White arrow shows a small branch which is 54 μm in diameter.

3 Conclusion

These results demonstrate the effectiveness of SRCA for visualizing the coronary artery in an in-vivo rat. Our method of using a bradycardic agent was simple and could improve the temporal resolution of SRCA. [2].

References

[1] S. Matsushita, *et al. Eur . J. Radiol.* 68, S84 (2008).

[2] H. Sakamoto, *et al. Acta. Radiologica.* (2015), in press.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number 25350879.

* sakamotoh@md.tsukuba.ac.jp