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Measurement of pulmonary arterial flow velocity in high flow pulmonary hypertension rat model using synchrotron radiation pulmonary micro-angiography

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1 Introduction

Congenital heart disease with high pulmonary flow is frequently complicated by the development of irreversible pulmonary hypertension. The increased pulmonary flow and shear stress may trigger endothelial cell dysfunction and unfavorable vascular remodeling which increases vascular resistance, although the detailed mechanism is still unknown.

Visualization of the micro vasculature bed and the measurement of blood flow velocity in pulmonary hypertension rat would provide the insight for evaluating endothelial reactivity caused by shear stress derived from high pulmonary flow and help to understand the mechanism of vascular remodeling. In this study, we aimed to establish the method of the synchrotron radiation pulmonary micro-angiography and measure the pulmonary flow velocity in *in-vivo* pulmonary hypertension rat model.

2 Experiment

Synchrotron radiation pulmonary micro-angiography was performed at the Photon Factory of the High Energy Accelerator Research Organization（Tsukuba, Japan) using a 6.5GeV electron beam. The advantages of synchrotron radiation derived X-ray is high spatial resolution due to increased photon density and straightness of the waves. High density resolution is obtained from high-sensitivity HARP (high-gain Avalanche Rushing amorphous Photoconductor) detector camera provided by NHK Science and Technical Research Laboratories. Our preliminary study showed that the diameter of minimum identified pulmonary arteriole was 100 μm.

As a high flow pulmonary hypertension rat model, an arterio-venous fistula between abdominal aorta and inferior vena cava was created in male Wistar rat. After 8 weeks, pulmonary micro-angiography was performed by transvenous infusion via right jugular vein. The dynamic change of density at the right main pulmonary artery (RPA), superior branch to inferior lobe (A6) and pulmonary arterioles (PA) lying under the visceral pleura was measured by computer-imaging program ImageJ. The transit time of contrast medium at each three point was also measured and pulmonary blood flow was calculated. Sham operated rat was used as control.

3 Results and Discussion

The velocity of proximal pulmonary artery (between RPA and A6) in pulmonary hypertension rat was 111.5±23.5 mm/sec and 117.0±13.5 mm/sec in control. By contrast, the velocity of distal pulmonary artery (between A6 and PA) was significantly increased as 71.7±23.2 mm/sec compared with control as 9.4±2.6 mm/sec ($p<0.05$).

4. Conclusion

This result demonstrates the effectiveness of the synchrotron radiation pulmonary micro-angiography to visualize the microvasculature in *in-vivo* pulmonary hypertension rat model. The pulmonary flow velocity was also able to measure and higher flow velocity at distal arteries was revealed. This newly developed technology to visualize the microvasculature may help to investigate the mechanism of vascular remodeling associated with pulmonary hypertension.

References

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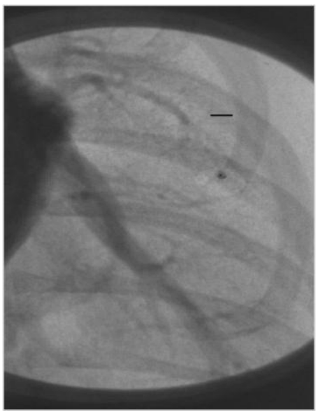

(Bar indicates 1 mm)

Fig. 1: Synchrotron radiation pulmonary micro-angiography with HARP receiver.