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Visualization of renal collecting duct using synchrotron radiation micro-angiography with highly sensitive receiver

Shonosuke Matsushita[1,*], Kazuyuki Hyodo[2], Chiho Tokunaga[3], Hiroaki Sakamoto[3], Shizu Aikawa[3], Yoshiharu Enomoto[3], Fujio Sato[1], Shinya Kanemoto[3], Mio Noma[3], Yuji Hiramatsu[3], Yuzuru Sakakibara[3]

[1]Department of Health Science, Tsukuba University of Technology, Tsukuba 305-8521, Japan
[2]Photon Factory, Tsukuba 305-0801, Japan
[3]Department of Cardiovascular Surgery, Graduate School of Comprehensive Human Science, University of Tsukuba, Tsukuba 305-8575, Japan

1 Introduction

The kidneys are organs that serve several essential regulatory roles including urinary system and homeostatic functions such as the regulation of electrolytes, maintenance of acid-base balance, and regulation of blood pressure. Drip infusion pyelography is used to visualize the passage of contrast material to urinary system. However, in this system, renal pelvis is the first identified intrarenal structure, and collecting duct is not seen due to limitation of spatial and density resolution of conventional X-ray system. Since we have developed highly sensitive synchrotron radiation micro-angiography [1], we tried to visualize intrarenal duct using transvenous infusion of contrast material.

2 Experiment

Synchrotron radiation micro-angiography was performed at Photon Factory (PF and PF-AR) in KEK. Synchrotron radiation was obtained from a 6.5-GeV electron beam in PF-AR and 2.5-GeV in PF. Synchrotron radiation was converted to monochromatic x-rays by reflection on a silicon crystal. The energy of the monochromatic x-rays was 33.3 keV. After passing the subject, the x-rays were converted to visible light on a fluorescent screen made of cesium iodide. Receiver was used a highly sensitive HARP tube, which had been developed by Japan Broadcasting Corporation Science and Technical Research Laboratory [2]. It revealed at least 5 times sensitive in density resolution than conventional CCD angiographic system previously [1]. Contrast material (32% non-ionic iodine contained) was infused from right jugular vein of male Wistar rat at a rate of 1 ml/sec in 2 seconds. Several minutes later, the continuous images of kidney were captured with our system.

3 Results and Discussion

Whole shape of single kidney was imaged with many collecting ducts toward renal pelvis (Fig. 1) at PF-AR. In images at PF, enlarged shape of collecting duct was visualized (Fig. 2). In movie format, movement of contrast material in collecting duct was observed. Since contrast material is largely diluted in urine at level of collecting duct, it seems that the image of contrast material in collecting duct cannot be visualized without the use of highly sensitive receiver like HARP tube equipped with synchrotron radiation.

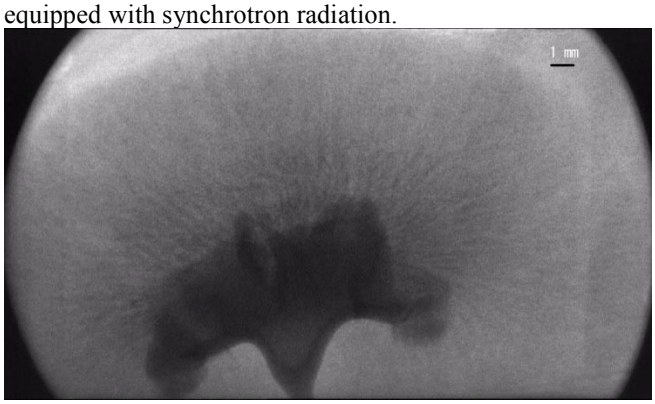

Fig. 1: Kidney showing collecting ducts at PF-AR.

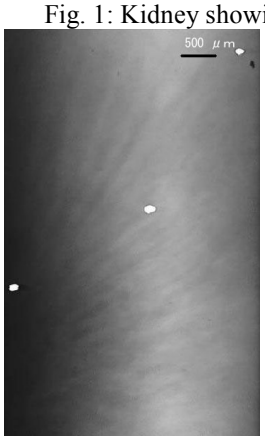

Fig. 2: Enlarged image of collecting ducts taken at PF.

4. Conclusion

The use of HARP tube enabled to visualize the shape of collecting tube of rat kidney. With this system, the size and flow of collecting ducts can be measured. It will be of help to understand the pathophysiology of collecting tube in various diseases from the aspect of flow visualization.

References

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* shomatsu@k.tsukuba-tech.ac.jp