

In Vivo X-ray Angiography of Mouse Brain using Synchrotron Radiation

X-ray angiography using a contrast agent has the main advantage of being able to simultaneously demonstrate the anatomy of vessels and changes in morphology. In rats, morphological changes and different vasoreactivities have been studied by angiography; however, the spatial resolution has not been sufficient to detect detailed changes in vessel diameter. Furthermore, owing to the relatively large volume of contrast agent (300-500 μ l) required for such studies, imaging studies could not be repeated in each rat. We previously developed an angiography technique using SPing-8, a third generation synchrotron radiation facility. With highly monochromatic synchrotron radiation as an X-ray source and a newly developed X-ray direct-conversion-type VIDICON camera, our previous study showed rat cerebral perforating arteries [1]. We, then, for the first time, performed *in vivo* X-ray angiography of the mouse brain using beamline BL28B2 [2].

A thin PE-50 tube was placed in the unilateral external carotid artery in adult male C57Black/6J mice. While maintaining the blood flow in the internal carotid artery, 33 μ l of contrast agent was injected, and then

selective angiography of the hemisphere was performed. The average diameters of cerebral artery were as follows: 142.5 \pm 7.90 in the middle cerebral artery, 138.3 \pm 9.35 in the anterior cerebral artery, 120.5 \pm 5.53 in the posterior cerebral artery, and 162.6 \pm 10.87 in the internal carotid artery (μ m, n=5). To demonstrate the changes in diameter, we induced hypercapnia and detected the dilatation of the vessels between 121 and 124 % of the original diameters (n=5). We also repeated angiography in the mice before and after intracarotid injection of vasodilatation drugs: papaverine hydrochloride, adenosine 5'-triphosphate disodium, and fasudil hydrochloride hydrate. We demonstrated the chronological changes in diameter in each artery 1, 5, 15, and 30 minutes after injection (n = 1 for each drug). As a result, using only a minimum volume of the contrast agent, synchrotron radiation enables us to conduct X-ray angiography of the mouse brain. The morphology of the vessels can be clearly observed under physiological conditions. The diameter of vessels and changes in diameter can also be successfully determined *in vivo*.

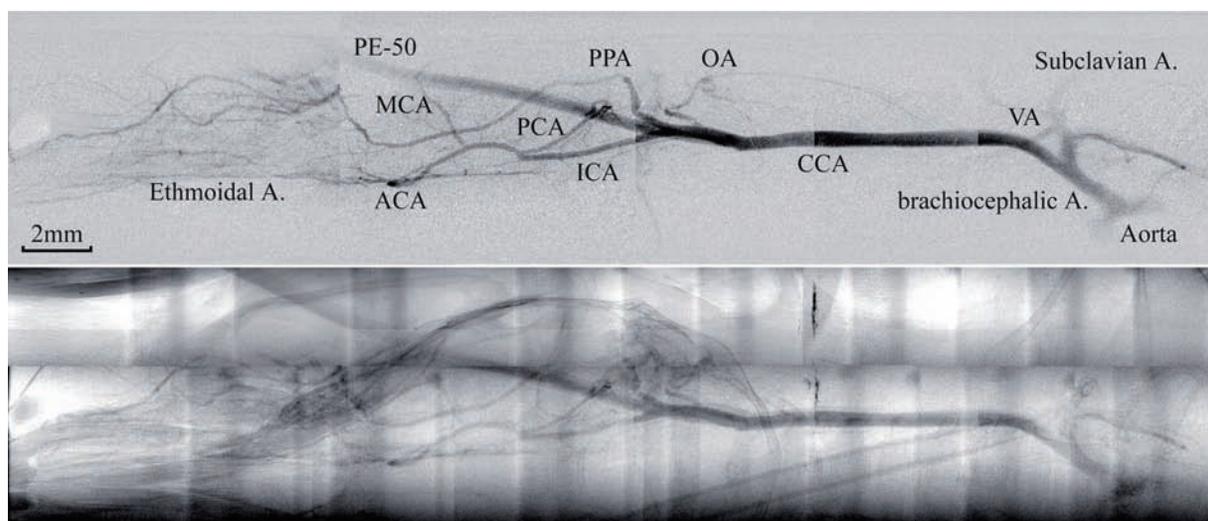


Fig. 1. Synchrotron radiation X-ray angiography of mouse showing anatomy of cerebral arteries in brain hemisphere and neck. Note that selective imaging was performed in the ICA territory. A subtraction image of the vessels (*upper*) and the original image with the skull (*lower*). Assembled with 4 to 8 images for each. CCA, common carotid artery; ECA, external carotid artery; ICA, internal carotid artery; OA, occipital artery; PPA, pterigopalathine artery.

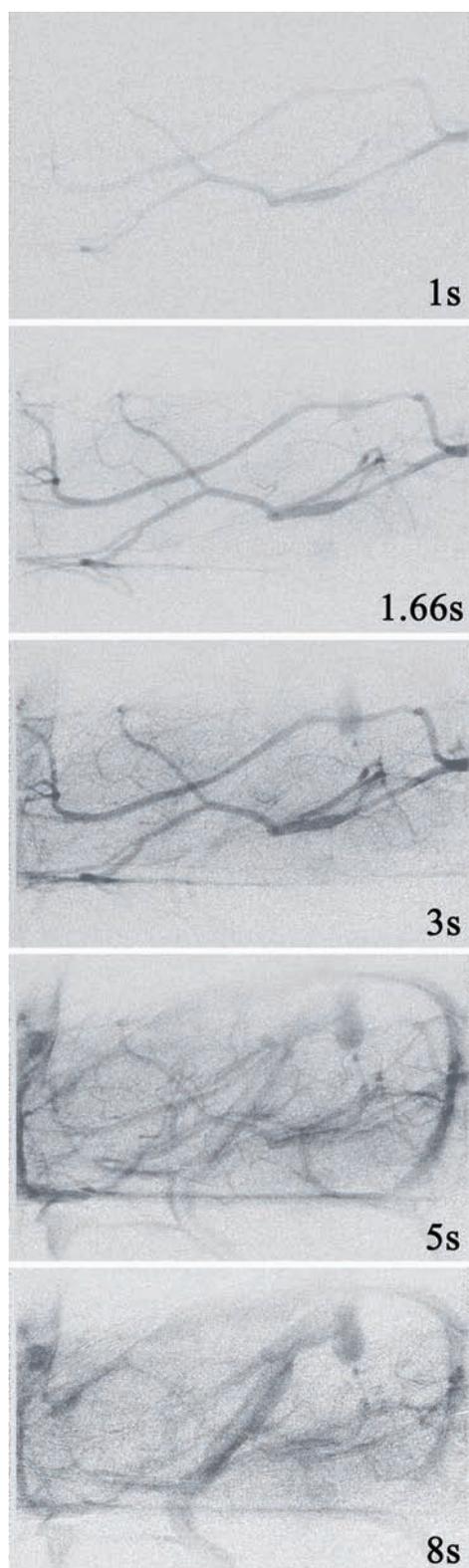


Fig. 2. Serial images from arterial phase to venous phase 1.0, 1.66, 3.0, 5.0, and 8.0 seconds after the start of contrast agent injection.

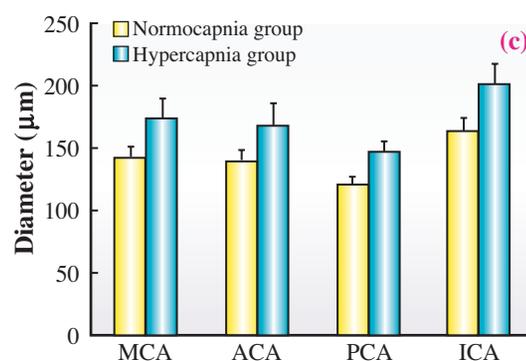
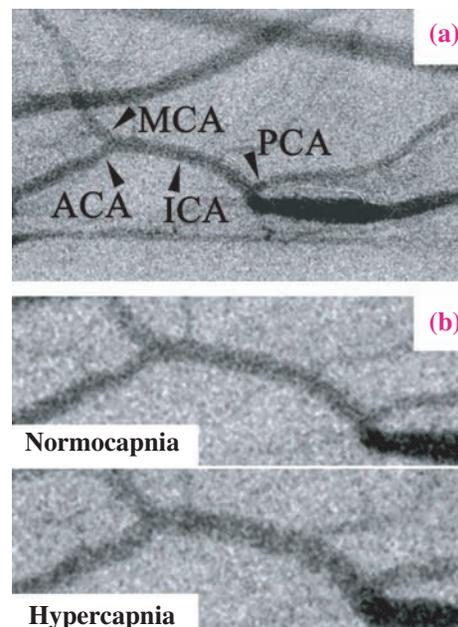


Fig. 3. (a) Image showing points for measurement of diameter of each artery. (b) Images showing distension of arteries under hypercapnia. (c) Comparison of diameters of cerebral arteries of mouse brain under normocapnia and under hypercapnia.

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References

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