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In vivo imaging of renal microvasculature in murine ischemia-reperfusion injury models using optical coherence tomography angiography

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Objectives: Optical Coherence Tomography Angiography (OCTA) is a non-invasive imaging modality that provides three-dimensional microvascular structure imaging and relative blood flow velocity of the biological tissue in vivo. We invented OCTA for an ischemia-reperfusion injury (IRI) kidney model and investigated the correlation of the changes in renal microvasculature with ischemic damage.

Methods: A prototype SS-OCTA system centered at 1300 nm with an A-line rate of 220.4 kHz and custom fixing tools were used for kidney imaging. Mice were divided into two groups according to the ischemic time: 10 and 35 min for the mild and moderate IRI groups. Intensity decorrelation was computed from 3 consecutive B-scans acquired at the same position to visualize kidney microvasculature. Semi-quantitative OCTA images were constructed at baseline and 1, 15, 30, 45, and 60 min after the ischemia. We analyzed the changes in the structural and flow speed of superficial (50-70 μm) and deep (220-340 μm) capillaries.

Results: Mild IRI group showed no obvious changes in superficial and deep blood flows. However, moderate IRI group revealed decreased superficial blood flow from 15 min and deep blood flow from 45 min after reperfusion and did not recover until 60 min. When comparing the two groups, superficial blood flow in the moderate group decreased significantly from 15 minutes, whereas no difference was observed in deep blood flow. The moderate IRI group showed significantly decreased kidney function and increased collagen deposition compared to the mild IRI group 7 weeks after IRI.

Conclusions: OCTA could find the changes in superficial blood flow after ischemic kidney injury. The decreased superficial blood flow rather than deep blood flow was associated with sustained dysfunction after IRI. Investigation of IRI kidney microvasculature damage using OCTA may better understand the relation between the extent of ischemic insult and allograft function.

Figure 1. OCT images of IRI mouse

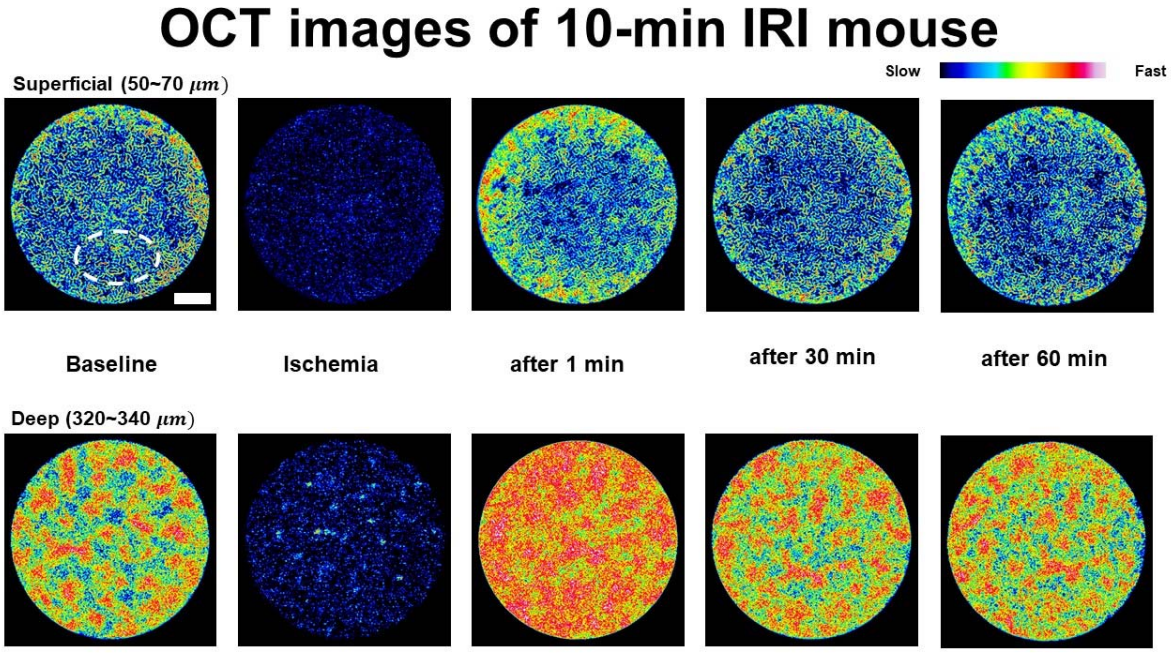

Figure 2. Changes in superficial blood flow of IRI groups