Assessment of Cerebral Autoregulation by Inducing Acute Hypertension in Rats (#18747)

We developed a rat model of acute hypertension by occluding the descending aorta and used cerebral blood flow (CBF) MRI to evaluate cerebral autoregulation (CA) dynamically under normocapnia and hypercapnia. Fig 1 shows time courses of blood pressure (BP), heart rate (HR), CBF and %BOLD associated with the balloon occlusion under normocapnia from one typical trail. CBF declined slowly toward baseline after its initial increase during sustained BP elevation. BP, CBF and BOLD undershot immediately after the deflating the balloon occluder. CBF returned to the baseline at a faster rate (~3x) under normocapnia than under hypercapnia (Fig 2). There is also absence of correlation between ΔCBF and ΔBP under normocapnia but not under hypercapnia (Fig 3). These indicate CA under normocapnia and CA impairment under hypercapnia. This approach sets the stage for study of CA in rat models of chronic hypertension, stroke and diabetes.

Fig 1. Blood pressure (BP), heart rate (HR), cerebral blood flow (CBF) and BOLD signal percentage changes during acute hypertension under normocapnia from one typical trail. Occlusion duration (1 min) is indicated by the shaded area.

Fig 2: (A) & (B): Trend lines were fitted to the CBF time courses during the aorta occlusion period using simple linear regression for all trials. The figures shows examples of two typical trails. (C) The median of the slopes under both conditions were significantly below zero (p = 0.0001 and 0.0012). This means that the CBF returned toward baseline after initial increase at a median rates of $-3.28 \times 10^{-3}$ ml/g/min/sec under the normocapnia, which is significantly faster than the median rate of $-0.962 \times 10^{-3}$ ml/g/min/sec under hypercapnia (p = 0.047). Therefore, under the normocapnia, the CBF returned back to the baseline at 3.4 times of the speed as it did under the hypercapnia.

Fig 3. A) Normocapnia: ΔCBF only increases by a constant of 0.18 ml/g/min and is not correlated to ΔBP ($p_{slope} = 0.53$ and $p_{intercept} < 0.001$), where the absence of the correlation between ΔCBF and ΔBP indicates existence of cerebral autoregulation. B) Hypercapnia: ΔCBF linearly increases with ΔBP ($p_{slope} = 0.002$ & $p_{intercept} = 0.41$), which indicates cerebral autoregulation impairment.