Cerebral Blood Flow in the Baboon Following Carotid Ligation: Effects of Hypoxia and Hypotension

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Following carotid ligation in the neck, there is a considerable risk of ischemia of the ipsilateral hemisphere. Neurological complications may develop immediately because of poor collateral circulation. More often, this complication develops later, in a period ranging from a few hours to a few days. The reason for the development of delayed complications is not known.

In a previous paper (3) it has been shown that although there is little fall in the blood flow to the ipsilateral cerebral hemisphere following carotid ligation, the CO₂ reactivity of the cerebral vessels diminishes.

This paper presents the results of experiments designed to show the state of reactivity of the cerebral circulation in anesthetized baboons to hypoxia and hemorrhagic hypotension before and after ipsilateral carotid ligation.

**Materials and Methods**

Baboons (Papio cynocephalus) weighing approximately 10 kg were anesthetized with phencyclidine and N₂O, intubated, and connected to a respiratory pump. The right side of the neck was dissected, exposing the right common carotid artery and its branches. The branches of the external carotid artery were ligated, except for the linguofacial trunk, which was cannulated centripetally. The scalp and temporal muscles were excised on the right side.

Cerebral blood flow (CBF) was measured by the height/area technique over periods of 10 min, using a bolus injection of ¹³³Xe via the right linguofacial trunk (2). Normocapnia was maintained throughout these experiments.

The effect of hypoxia and carotid ligation on CBF was tested on five baboons. In these experiments, after initial control CBF estimations, hypoxia was induced by reducing the oxygen in the gas inhalation mixture. After CBF measurement at hypoxia, the oxygen in the gas inhalation mixture was restored and CBF measured at normal PaO₂. The right common carotid artery was then ligated and CBF measured at normal PaO₂ and then at hypoxia.

In another 10 baboons, after initial control CBF measurements, the right common carotid arteries were tied and the animals were then rendered progressively hypotensive by controlled withdrawal of blood via a catheter in the right femoral artery. CBF was measured following each step-reduction in the blood pressure, which was held steady for at least 5 min prior to and during the 10-min period of CBF estimations.

A similar protocol was used in another series of experiments in this laboratory, in which the effect of controlled hemorrhagic hypotension on CBF was measured in 10 animals with intact carotid arteries (1). These last experiments were used as controls for the present series.

**Results**

**Hypoxia Experiments (Five Animals)**

There was no significant difference in CBF values before and after ipsilateral carotid ligation under normoxic conditions. The increase in flow
following hypoxia was significantly less after ipsilateral carotid ligation. Before carotid ligation, hypoxia (PaO₂, 38 mm Hg) produced an 81% increase in CBF, but after ipsilateral carotid ligation, hypoxia (PaO₂, 34 mm Hg) increased CBF by only 20% (Fig. 1.).

The difference in the PaCO₂, PaO₂, and MABP values before and following ipsilateral carotid ligation was not significant.

**Hemorrhagic Hypotension Experiments (Ten Animals)**

The mean CBF and MABP values in each animal following ipsilateral carotid ligation, but before withdrawal of blood, were taken as control values. Percentage changes from the control values were calculated for the MABP and CBF values obtained before hemorrhage and during each step-reduction in the systemic blood pressure. These values obtained from all animals are plotted in Fig. 2. Following ipsilateral carotid ligation, CBF fell pari passu with fall in MABP; i.e., autoregulation became impaired. The calculated regression line was $y = 32.248 + 0.714x; r = 0.824; n = 71; P < 0.001$. These results are in contradiction to those found by Fitch et al. (1), who demonstrated autoregulation to hemorrhagic hypotension in baboons.

**Discussion**

The baboon is a suitable animal for cerebral blood flow experiments because of the anatomical and physiological similarity to man. Throughout these experiments steps were taken to ensure steady-state conditions in respect to those physiological variables considered of importance in the control of the cerebral circulation.

Before carotid ligation, hypoxia (PaO₂, 38 mm Hg) produced an 81% rise in CBF, whereas following ipsilateral carotid artery ligation, hypoxia (PaO₂, 34 mm Hg) increased CBF by only 20%. Ipsilateral carotid ligation thus impairs the response of the cerebral vessels to hypoxia.

The maintenance of CBF in the face of arterial hypotension is well accepted and is believed to be maintained by dilatation of the arterioles.