Institute of Medical Physics TNO, Da Costakade 45, Utrecht, The Netherlands

Haemodynamic Changes in the Cerebral Circulation of the Cat During Occlusion of the Middle Cerebral Artery

By


With 4 Figures

Summary

In a group of 21 cats, the middle cerebral artery pressure (MCAP) was recorded by means of a catheter introduced into the artery at its origin, just distal to the occlusion. The effects of hypertension, hypercapnia, and hypocapnia were studied.

In a group of five cats, both middle cerebral arteries (MCA) were catheterized and the pressure was recorded simultaneously on both sides.

In another group of five cats, O₂ tension measurements were made with the aid of oxygen electrodes in the brain tissue, the occluded MCA, and the common carotid artery.

Some of the results obtained in this study are compared with the results of a previous study where monkeys were used as experimental animals.

Introduction

When a major brain artery distal from the circle of Willis is occluded, blood flow to the ischaemic brain area is provided by the so-called leptomeningeal collateral circulation. The effectiveness of the collateral flow depends on the number and the size of the collateral channels as well as on factors such as PaCO₂ and systemic arterial blood pressure.

The aim of the experiments reported in this communication was to obtain a better insight into the function of the leptomeningeal collateral circulation and to determine the factors which can influence this collateral circulation in a favourable way.

* C. A. F. Tulleken is neurosurgeon at the Ursula Kliniek and staff member of the TNO-GO Workgroup in Clinical Neurophysiology, both at Wassenaar.
Symon (1968), Kogure et al. (1969), and Brawley et al. (1967) studied the haemodynamic changes in the leptomeningeal circulation after occlusion of the middle cerebral artery in monkeys and dogs, with the aid of a catheter introduced into a cortical branch of this artery.

We used an experimental animal model where a catheter was introduced into the most proximal portion of the middle cerebral artery with the tip in the distal direction of the vessel. The artery was occluded at its origin prior to the introduction of the catheter.

The drawbacks and the advantages of this method were discussed in a previous report, which contains the results of experiments in 12 monkeys (Tulleken and Abraham 1975). This presentation is concerned with experiments in 31 cats. The results are compared with the results in the monkeys.

Methods

**Group 1 (21 Cats)**

General anaesthesia was obtained with pentobarbital sodium (25 mg/kg body weight) injected intraperitonially to start with; the anaesthesia was maintained by additional injections intravenously. A Millar catheter was placed in one femoral artery and pushed upwards until the tip was in the aortic arch. The systemic arterial blood pressure (SABP) was continuously recorded by means of this catheter. Another catheter was introduced into the femoral vein for i.v. injections and infusions.

Tracheostomy was performed, and a tracheal cannula, which was connected to a Harvard animal respirator, was introduced. The animal was placed in the prone position with the head fixed in a stereotaxic head standard. A catheter was introduced by means of the transorbital approach (Hudgins and Garcia 1970), and, with the aid of the Zeiss operating microscope, into the origin of the right middle cerebral artery, with the tip pointing distally. The pressure in the occluded middle cerebral artery (MCAP) was continuously recorded via this catheter which was connected to a Statham Strain Gauge. The end Tidal CO₂ was continuously recorded with a capnograph. In three animals, the orbit was closed in a watertight manner with dental cement after introduction of the catheter, and the intracranial pressure (ICP) was continuously recorded via a Millar catheter in the subarachnoid space (basal cisterns). In the remaining 18 animals, the orbit was left open. As a measure of collateral circulation, we used the ratio \( \frac{MCAP}{mSABP} \) as a percentage.

The recordings were made during a period of 3–4 hours following occlusion of the middle cerebral artery. The PaCO₂ was influenced by hyperventilation (hypocapnia) and inhalation of a mixture of 8% CO₂ and air (hypercapnia). Hypertension was induced by infusion of a metaraminol tartrate in saline solution (30 mg/500 ml saline).

An infusion rate of about 0.012 ml (= 3 drips)/minute was sufficient in most animals to induce an increase in mSABP of about 50 mm Hg. Besides an increase in pulse rate no side effects of the metaraminol tartrate infusion were noted.