OBSERVATIONS ON THE INTERRELATIONSHIPS OF INTRACRANIAL PRESSURE AND CEREBRAL BLOOD FLOW*

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DURING the development of a method for recording continuously the intracranial pressure of rhesus monkeys, we observed that changes in hemodynamics have a profound influence on the intracranial pressure. The present communication deals with the experimental evidence which shows that the rate of intracranial blood flow is one of the important variables determining the intracranial pressure.

MATERIALS AND METHODS

Our observations are derived from acute experiments on rhesus monkeys anesthetized with intravenous nembutal. The intracranial and spinal fluid pressures were measured by methods which have been described elsewhere. The superior or inferior caval pressures were obtained by inserting a plastic catheter into the vessel through the internal jugular or the femoral vein. Regurgitant flow and clotting of blood in the catheter were obviated by a constant leak of heparinized saline under high pressure into the catheter.

The position of the catheter was verified in vivo by the pressure obtained, and at autopsy by inspection. The pressure in the abdominal aorta was obtained by inserting a similar catheter through the femoral artery.

Changes in intracranial volume were induced by injecting oil into the extradural space through a tap screwed into the skull, or into the intracerebral substance through a needle inserted into the frontal or occipital pole on the side opposite the insertion of an intracerebral balloon needle. Saline was added to the cerebrospinal fluid and cerebrospinal fluid was withdrawn through the ventricular needle or through a needle inserted into the lumbar subarachnoid space. Inflation of a cuff placed about the neck increased the intracranial venous blood volume by compressing the venous outflow from the head.

Changes in the cardiac output were estimated from the arterial pressure pulses. The cerebral blood flow was modified by occlusion of one or both carotid arteries, by modification of the cardiac output through vagal stimulation or section, by the inhalation or intravenous injection of various drugs,

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by the induction of hemorrhage following section of the aorta or inferior vena cava, by clamping the trachea, or by inducing changes in intracranial volume by adding oil and saline to the intracranial cavity. Changes in cerebral blood flow were not directly measured, but were inferred from the known or expected effects of the procedures used, and from the observed modifications in the recorded intracranial, sinus, caval and arterial pressures.

FIO. 1. Pressure responses to the intracranial introduction of oil.

The pressures in a needle in the lateral ventricle \((P_{LV})\) and catheters in the femoral artery \((P_A)\), the inferior vena cava \((P_{CAV})\), and the sigmoid sinus \((P_B)\) are recorded in mm. of water, except for \(P_A\) which is in mm. of mercury. The paper speed was increased at the end to 6.25 times the initial speed.

The injection of oil causes an immediate pressor response in the ventricle and the artery. This response is complicated by heart block. The sinus response is depressor, follows the arterial pressure closely, and is independent of the caval pressure.

OBSERVATIONS

**Intracranial Oil Injection.** The extradural or intracerebral injection of oil in the course of a few seconds causes a concomitant rise in intracranial pressure. The pressure falls, after a transient peak, to levels that remain somewhat higher than the initial level (Figs. 1, 2, and 3). As long as the cardiac output remains essentially unchanged, the further injection of equal volumes of oil causes disproportionately high increases in the pressure, and the intracranial pulse pressure becomes higher, and the usual respiratory variations in blood pressure more marked (Fig. 11). The continued injection finally causes such respiratory effects as irregular deep respiration or apnoea, and the induction of cardiac dysrhythmias and changes in form of the ventricular complexes of the electrocardiogram, with a fall in blood pressure. The intracranial pressure invariably falls with this fall in the blood pressure. The injection of further increments of oil causes a less marked and more